MARCH, 1937

Engineering and Mining Journal

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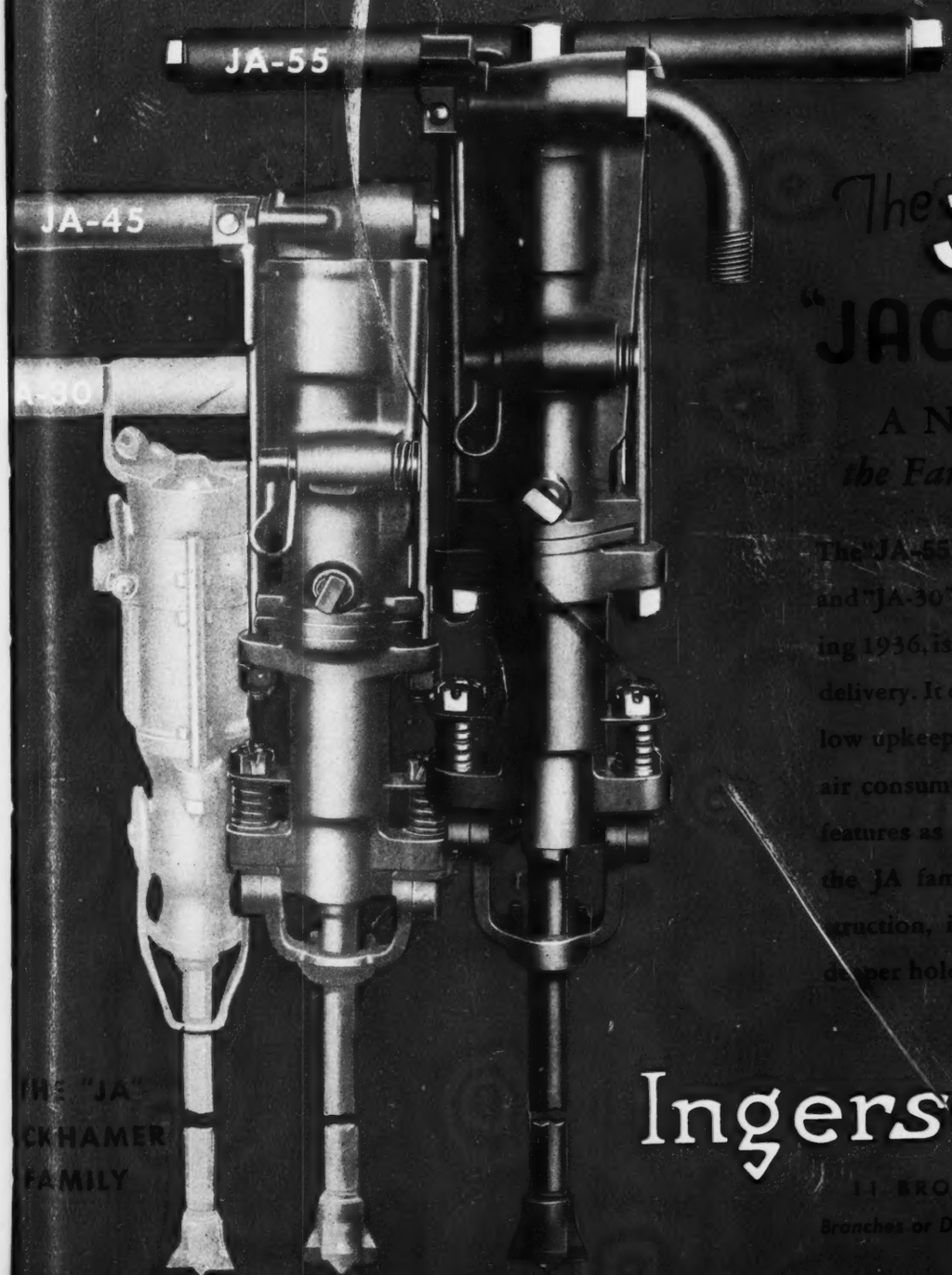

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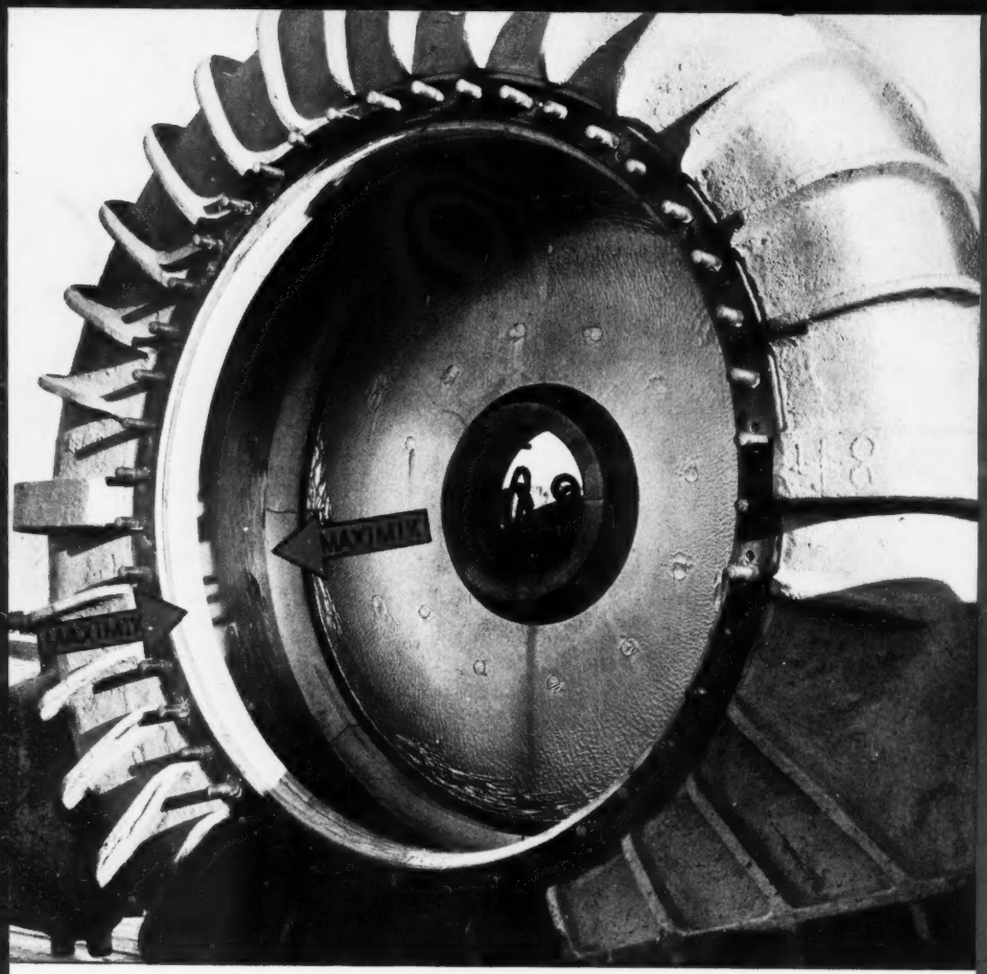

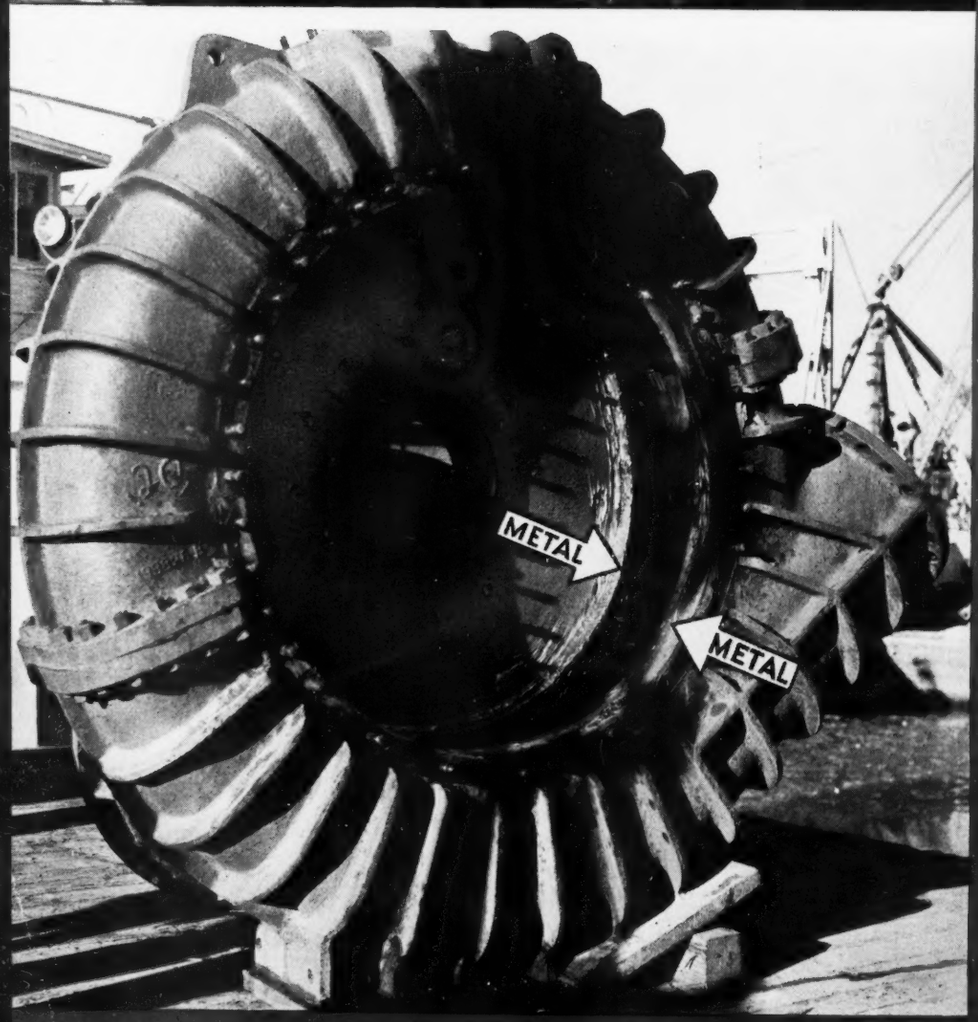

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Copper Phobia. January 13, 1937, should be a red-letter day in Congress, for on that date Representative Hook (Dem., Mich.) introduced H.R. 2896 "to prohibit the importation of copper." Not forever, of course, but only until "the President of the United States finds that copper *ore* in the United States shall have maintained a price of 20c. per pound for thirty days, on the New York market." Then the embargo shall be raised. But—imports of copper shall still be subject to a duty of 15c. per pound. As price boosters the London speculators are pikers. They'll probably break down and weep when they hear of Mr. Hook's plan to keep copper out of the United States—out of the market, for that matter.

▼

Depreciation reserve policies warrant study by mining companies. If unsound, because of ignorance of true costs, they may be reflected in reduction of ability to modernize, depletion of capital, loss on sale of product, and in other ways. The report of a committee appointed by the Machinery and Allied Products Institute to study this matter has recently been published by that body. A digest of it will be printed next month.

▼

Mining Locomotives. Shipments of electric locomotives for mining use increased sharply in 1936, totaling 344, as compared with 197 for 1935. The previous high record was 258, in 1934. Of the 1936 total, 187 were of the trolley type and 157 storage-battery. For the fourth quarter of the year total shipments were 104, of which 56 were storage-battery and 48 trolley. The total value of 1936 shipments was $1,792,988, of which $1,335,493 was for trolley locomotives.

▼

No Help Wanted. A poor farmer in South Africa recently found an outcrop of high-grade gold ore on his land. The law says he may till his soil, but to mine his property fees and deposits totaling $285 must be paid. He has refused financial aid and intends to wait for a bumper crop to finance his mine promotion.

H. C. PARMELEE
Editorial Director

Engineering and Mining Journal

A. W. FISHER
Manager

Published by McGraw-Hill Publishing Co., Inc.
WILLARD CHEVALIER
Vice-President

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The Tropics present many hazards to health, especially to those accustomed to life in temperate climates. This everyone knows, but not every engineer understands how to equip himself for a journey thither and how to take care of himself when he gets there. Lucien Eaton, well-known to *E. & M. J.* readers as a contributor, has taken the pains to prepare an article discussing this subject in detail, utilizing his own experience on many tropical journeys as a basis. This will appear in April.

Besides gold, one of the things an hydraulic mining project needs to insure success is an efficient sluice system for saving the precious metal. How to design and build it is told by W. A. Newman, consulting engineer, of Berkeley, Calif., in an article that he has written for the April number.

▼

100 Years Ago. The *Mining Journal,* London, reprints from its issue of Jan. 21, 1837, the following observation on booms and depressions: "It is by no means difficult to discover the cause of these periodical fluctuations; they arise from the immense accumulation of wealth which, in this great commercial country is at all times going on, and which occasionally reaches a point where profitable investment in the ordinary channels can no longer be found. A reign of enterprise and speculation then begins, and every scheme which has outward plausibility to recommend it is eagerly embraced." Sounds familiar.

Published monthly. Subscription rates, United States and Canada, $3 per annum; other countries in the Americas outside the United States and Canada, $4 per annum; elsewhere $5 or 20 shillings per annum. Price per copy, 50c or 2s. Application for entry as second-class matter at Albany, N. Y., pending. Printed in U. S. A.

McGRAW-HILL PUBLISHING COMPANY, INC.
Publication Office, 99-129 North Broadway, Albany, N. Y.
Editorial and Business Offices, 300 W. 42d St., New York, N. Y.
Cable Address: McGraw-Hill, N. Y.
San Francisco: 883 Mission Street
Chicago: 520 North Michigan Avenue
Washington, D. C.: National Press Building

McGRAW-HILL PUBLISHING COMPANY, LTD.
Aldwych House, Aldwych,
London, W.C.2, England
Cable Address: Backlash, Estrand, London

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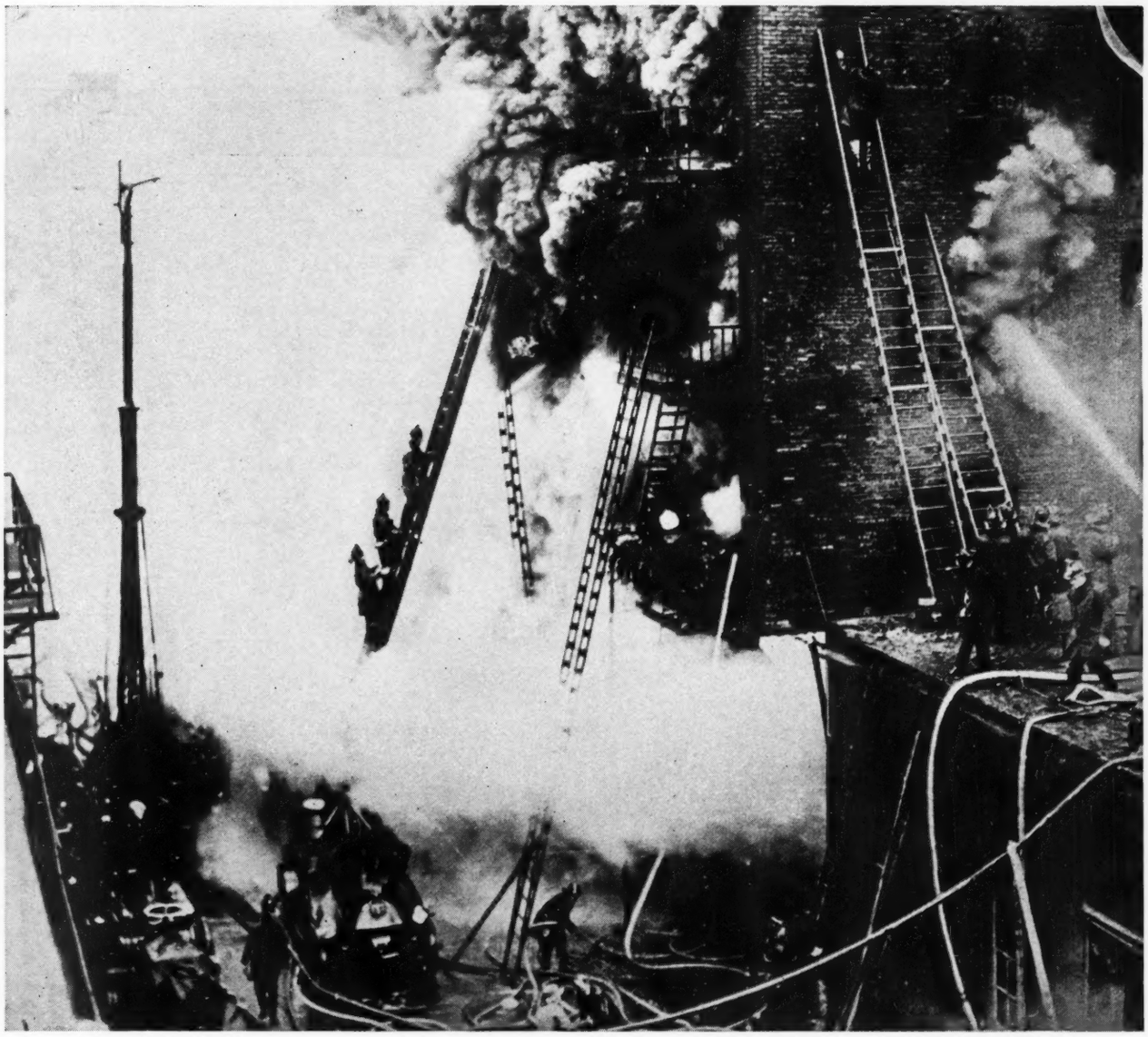

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(Another story of Goodrich development work appears on the page opposite the third cover.)

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Volume 138 Number 3

MARCH 1937

Mad Metal Markets

THOUGH it is difficult, if not impossible, to name a fair price for almost any commodity under present topsy-turvy monetary and political conditions, the rapidity with which prices of copper, lead, and zinc have risen under the frenzied buying in London certainly points to trouble ahead unless some sobering influence can be brought to bear upon the situation. The London speculative boom in non-ferrous metals has succeeded in thoroughly disorganizing the plans of producers to provide for an abundant supply of copper, lead, and zinc, and more recently tin, at a price level that would encourage extension in the uses of these important commodities.

There is a growing disposition among consumers to blame producers because they have permitted speculators to gain control over prices. Perhaps the producers did cling to the conservative side too long in order to get prices up to a more profitable basis, for as recently as last summer a weak undertone was discernible in base metals. But planning was all the rage. Even Governments, as in the case of tin, stepped in to render assistance in establishing an orderly economic cycle. Business men were told that the peaks and valleys in the business cycle would have to be flattened out perceptibly. The objective everywhere was to keep production and consumption in balance. Surplus metal stocks were reduced, thanks to business recovery and production controls, and an orderly advance in prices set in.

Because of the improvement in business and rising prices, consumers increased their working stocks and extended purchases of metal well into the future. Forward sales of copper in the United States market at the end of February were more than 400,000 tons, equal to about five months' consumption. True, some consumers refrained from taking on the metal in volume, and this group is now clamoring for copper in an almost bare market. But, in the main, consumers here should be satisfied, having purchased the bulk of their near-by, and in many instances forward, requirements at much lower prices than those now prevailing.

As usual, the unexpected has happened. With world producers well sold ahead, and the statistics pointing to a strong market, particularly in copper, the speculator and investor took hold of the situation in London. "Hot money" interests joined the parade. Early success in raising prices increased the speculative fever. Producers soon announced that all production restrictions had been removed, but this failed to arrest the movement. From copper the buying wave spread to lead and zinc. Tin also came in for greater attention. The speculators, believing that recovery in world trade plus rearmament would take more metal from the market than producers could provide, came back for additional tonnages at rising prices. After all other reasons for a booming market became exhausted, they fell back on revaluation of commodity prices in terms of cheapened currencies, and translated current prices into the dead gold currencies of pre-depression days.

A revaluation of commodity prices in terms of cheapened currencies is probably taking place, but those who have made a careful study of such movements cling to the view that normally the upward trend would proceed in an orderly way and extend over a protracted period. By contrast we have seen copper jump from 12¢, Valley basis, on January 1 of this year to 15¢ on February 24. Lead moved upward from 6¢ New York, to 7¢ in about the same period, and zinc from 5.45¢, St. Louis, to 6.80¢.

Prevailing prices, whether high or low, depending on the views of those playing the game in London, are definitely stimulating production. World production of copper at present—mine and scrap—is at the rate of 2,300,000 tons a year. World apparent consumption in 1936

amounted to about 1,950,000 tons. Production of copper is still increasing and will continue to climb as the so-called marginal producers resume operations. In copper circles it is estimated that world production will expand to between 220,000 and 225,000 tons a month with copper above 13¢ per pound, or at the rate of 2,640,000 to 2,700,000 tons a year. The previous high mark in world consumption of copper was 2,100,000 tons, in 1929, or at the rate of 175,000 tons a month.

Recovery in world trade is expected to continue for some time, but it is doubtful if the rate will be so fast as to cause more than a temporary shortage in commodities. Certainly no lasting famine of non-ferrous metals is in sight. Producers know this full well and deplore the recent skyrocketing of prices. But fear grips consumers and they rush into the speculators' trap in spite of warning signals. It is time to stop, look, and listen if both producers and consumers are to avoid damaging consequences.

How Long?

THAT HARDY PERENNIAL—exemption from annual assessment work—has flowered again in Congress in the form of a bill—S. 187. And lest it be too easily found in the Committee on Mines and Mining, where such bills normally would be referred, it has been committed to the tender ministrations of the Committee on Public Lands and Surveys. Senator Murray, of Montana, sponsors the bill this year, doubtless at the urgent request of some of his constituents. In any event he has shown himself immune to our protest that it is high time the nonsense of exemption be stopped. If this Congress is to be deterred from extending the period of exemption it will be necessary for mining men as individuals and groups to register their views with their Congressmen.

For years *Engineering and Mining Journal* has waged a fight against this persistent folly. In May, 1936, we published a group of letters opposing further exemption, but the Congress paid no heed to that consensus of opinion. We believe that the sentiment then expressed still prevails, and that there is less reason for exemption now than there was then. Another year has passed and has brought a large measure of prosperity to the mining industry, with its attendant need for new development. To allow unpatented mining claims to escape assessment work this year will be a disservice to the mining industry. Confirmation is supplied by the Great American Prospectors Association, of Salt Lake City, which has gone on record as opposed to further exemption and has urgently requested all members of the Senate and House to allow the customary requirements to prevail. Similar action by other bodies of mining men may persuade this Congress to take a realistic, rather than a sentimental, point of view in the matter.

Mining Litigation Never Ending

DECISION by the United States Board of Tax Appeals, on February 11, that Hecla Mining Company is entitled to discovery depletion under the Revenue Act of 1928 with respect to the ore taken out of the so-called Intermediate vein in the Hecla mine, in Idaho, involves only the sum of approximately $185,500 previously alleged by the Internal Revenue Commissioner as the deficiency in income taxes for the years 1928 to 1931 inclusive arising from his disallowance of deductions for depletion. It is nevertheless interesting, both as news of the day and as a reminder that the Revenue Act of 1928 was only fair in re-enacting the provision of the earlier Act of 1926 that allowable discoveries "shall include minerals in commercial quantities contained within a vein or deposit discovered in an existing mine or mining tract by the taxpayer after February 28, 1913, if the vein or deposit thus discovered was not merely the uninterrupted extension of a continuing commercial vein or deposit already known to exist, and if the discovered minerals are of sufficient value and quantity that they could be separately mined and marketed at a profit."

With the computation of its tax for 1926 Hecla had exhausted the March 1, 1913, value (for depletion purposes) of the Hecla vein, and when subsequently it made deductions under the Act of 1928 for the depletion of the ore of the Intermediate vein in computing its taxes for the four years in dispute, these were disallowed, as stated. The company thus was put to the task of proving that the Intermediate vein, which in places lies close to the Hecla vein, was a new discovery (as of September 30, 1915, the Hecla vein having previously been worked for years) within the meaning of the Act of 1928. This its attorneys and experts have succeeded in doing, to the convincing of the Board of Tax Appeals.

Here, in the debate by both sides over the points of geology involved, we have the counterpart of the endless fights that have been waged over apex rights. And so we are reminded that, even though the mining law were revised beyond possibility of dispute, the tax gatherer can be counted on to keep lawyers and "court" geologists busy.

The Menace of DUST In Metal Mining

Uncertainties Confront the Operator . . . Prevention So Far as Possible the Safest Course

D. Harrington

Chief, Health and Safety Branch United States Bureau of Mines, Washington, D. C.

UNQUESTIONABLY, dust prevention is the surest means that the metal-mining industry can adopt to avoid complications or damage of various kinds caused by the dust produced in its operations. This constitutes a menace that now badly threatens it, as well as those engaged in tunneling and quarrying and similar operations. The industry should take advantage of the methods that are available for reducing air-dustiness in its mines and plants.

Vast amounts of information are available on the effect (respiratory and otherwise) of dust in mines and other industrial plants. Although these data are relatively definite as to some phases of dust occurrence, such as explosibility or non-explosibility, tendency to fire spontaneously, and numerous other physical and chemical features, there are numerous uncertainties regarding the effect of dust on the human body, especially almost every phase of the effect of breathing airborne dust. A possible exception is that harm to health can be expected from prolonged breathing of excessive amounts of dust (or at least some dusts) over considerable more or less consecutive periods of time.

Though dust harmfulness is by no means confined to what happens because of the breathing of dust, most of the emphasis on dust occurrence in industrial work at present is in connection with respiratory disease. However, there are many uncertainties as to almost all phases of the real or supposed harmfulness (respiratory or otherwise) of dust, including the manner in which dust that is breathed accomplishes its damage to health.

Present-day thought of the majority of those conversant with dust disease is largely crystallized in two ideas: (1) That maximum harm to health from dust is brought about by breathing silica dust (and chiefly *free silica*, SiO_2) in sizes of 10 microns or less (a micron being one thousandth of a millimeter or approximately one twenty-five thousandth of an inch); and (2) that the silica dust in the lungs dissolves in or is chemically combined with the fluids of the lung tissue, the resultant chemical action causing transformation (or fibrosis, as it is termed) or partial or entire destruction of the tissue at certain points, frequently bringing about a condition that induces or expedites tuberculosis of the lungs, with ultimate incapacitation and finally death. No known cure is available for silicosis, the worst of the dust diseases; hence, prevention is all-important.

Belief is now general that dust may be detrimental to health through its effect of one kind or other on the entire system, or on the throat, bronchial passages, lungs, stomach, and other internal organs, as well as on the eyes, the ears, the nose, and other external organs, and on the skin. Many dusts (metal, mineral, and organic) are explosive; others fire spontaneously with more or less readiness under varying conditions, and practically all dusts have almost universally detrimental effects when they settle, whether in the home, in the office, or on the external surfaces of buildings or on the roads, streets, or sidewalks. All of these facts, and numerous others could be added, make dust one of the real scourges of modern life; certainly no sane person can deny that a most determined effort should be made to reduce its occurrence or at least to confine it so as to minimize its multifarious harmful effects, not only on human beings but also on vegetation and animals, as well as on dwelling houses, machinery, and almost innumerable other factors of importance in modern existence.

A number of years ago the South African authorities tentatively and more or less arbitrarily set standards of maximum allowable air-dustiness in mines with bad records for dust disease as 300,000,000 particles by count of 5 mg. of dust by weight per cubic meter of air. This standard was set without reference to silica content, free or combined, and with little reference to particle sizes or any definite idea as to its efficacy in preventing the occurrence of dust disease.

The announcement has been made from time to time that air-dustiness in the mines of South Africa is kept fairly rigidly below both the standard weight and the count of particles and that new cases of miners' consumption (dust disease) are now practically unknown. One of the numerous difficulties in attempting to set any kind of standard is that the available analytical devices and methods of dust sampling and determination are anything but applicable or practicable or readily workable in connection with at least some industrial conditions, among them mining. Until or unless dust sampling and analytical devices and methods are so simplified that reasonable accuracy can be achieved by intelligent plant employees, rather than by relying on the services of a relatively few highly trained and highly paid technical experts holding a monopoly on the work, the institution of rigid laws or regulations as to allowable air-dustiness will probably result only in confusion and injustice.

In the maze of uncertainties connected with almost all phases of the causation and diagnosis of dust disease, about the only really well-determined fact available is that breathing large quantities of dust (or possibly of certain dusts) over extended periods is likely under some conditions to be harmful to health and that subsequent alleviation or cure is difficult or impossible. Therefore, it

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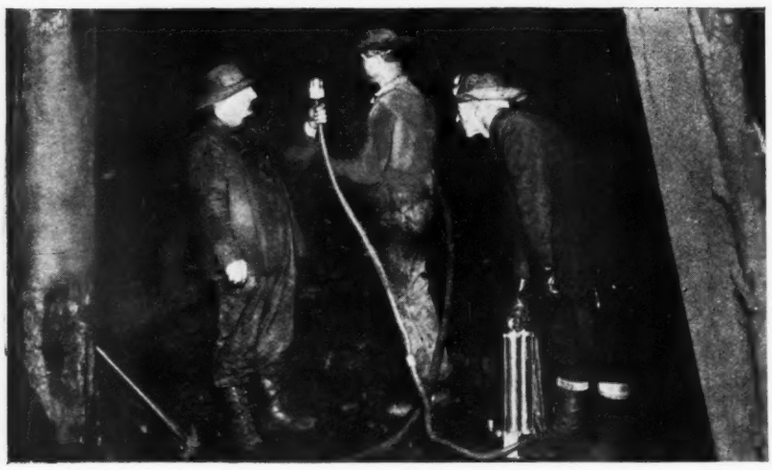
would seem to be logical to try to prevent dust formation or to remove dust as soon as possible after its formation, thus preventing it from harming workers through respiration or otherwise. Here is a real job for the engineer, and little or no help can be expected in these vital functions from any agency except the engineers and operating officials.

The most harmful of the ordinary dusts to breathe is probably silica dust, but, on the other hand, not even free silica, supposedly the most detrimental of the silica dusts, is harmful unless it is breathed in considerable *quantities* and over extended periods. No human being ever lived any considerable time on this earth of ours without breathing silica dust (free silica dust), yet by no means all of the people of the world have or have had silicosis. In other words, the *quantity* of dust taken into the respiratory organs is a controlling factor in dust respiratory harmfulness, and common sense indicates that the quantity of dust breathed is one of the dominant factors as to possible harmfulness from any kind of air-borne dust. What constitutes that quantity limit no human being knows, notwithstanding the fact that numerous so-called threshold limits are now being announced and that some of them are embodied in State regulations or laws.

Predicting dust respiratory harmfulness on a sliding scale in proportion to the free-silica content of the dust is anything but logical. In the first place, no one knows whether a dust of 1 per cent silica is or is not more harmful than a dust of 2 per cent or 3 per cent or even of 30 per cent. Moreover, air with a certain number of dust particles per cubic foot, with a silica content of 1 per cent, or any other percentage, probably would be far more harmful to one person than to another; to a person working on a contract basis with the added incentive for working at maximum capacity than to one on a day-pay basis; or to a person working in an atmosphere of 85 deg. or 90 deg. F., relative humidity 90 or 95 per cent, than to one working in an atmosphere of 60 deg. F., relative humidity 60 per cent. And there are numerous other more or less similar contributing factors that make unworkable or futile the establishment of regulations as to allowable number of dust particles on a sliding scale in proportion to silica content of the dust.

SAMPLING DUST in mine air with the sugar tube in a Lake Superior iron mine. This method of sampling is no longer used in the United States



DUST PREVENTION—one of its sources underground. Dry stopers such as these are sometimes known as "widow makers" by the miners because of the bad dust conditions they create

In some industries, such as metal mining and tunneling, there may be as many different percentages of silica in the mine air as there are places being worked, and in many metal mines it is entirely unlikely that the percentage of silica in the air of a working place today will be at all like the percentage of silica in that same place tomorrow. Application to most metal mines of the sliding scale of allowable number of dust particles in the air in proportion to silica content would be utterly impossible to enforce or fulfill.

In view of the numerous uncertainties as to the sampling and determining of air-dustiness, including equipment, methods of determining, so-called threshold limits, and numerous other phases of the technic of ascertaining the degree or amount of air-dustiness, the operating man is likely to be utterly confused as to what constitutes a dusty atmosphere. One common-sense answer is that any atmosphere in which dust is visible to the naked eye is certainly too dusty to be breathed with safety by human beings, and the wise, far-sighted, humane employer will immediately start to decrease the dust content in any atmosphere where dust is visible. After he has eliminated visible dust, there may still remain enough very small invisible dust to cause harm to the health of those who breathe it, but in any event if he has exerted sufficient well-directed effort to remove the visible dust, it is certain that much of the smaller invisible, and probably most harmful, dust has also been removed.

Manifestly, if dust is kept out of the air breathed by workers, the latter cannot succumb to dust disease of a respiratory character. In the elimination or at least limitation of dust in the air where men work, the mining man, therefore, has in his hands the really effective means of prevention

of respiratory harm from dust. Some suggestions are made to those engaged in metal mining as to feasible available methods of handling the dust problem.

The main sources of dust in metal-mine air, in the order of importance, are: Dry-drilling holes for blasting; blasting; shoveling or "mucking" very fine dry material at the working face, which is usually poorly ventilated; loading cars from chutes; dumping loaded cars into chutes; and timbering. Dry crushing and other occupations in metal-mine mills are also likely to be dangerously dusty.

The best remedy for the dust menace in mines, other than preventing its formation, appears to be the universal coursing of currents of air to remove the dust, as it has been proved that the very fine, most dangerous dust in metal mines remains suspended in still air for several hours. Dust-prevention devices of proved success, such as the present-day self-rotating wet stoper and other wet-drilling equipment, should entirely supplant dry drilling; their use should be enforced upon both miners and operators in metal mines. Care should be taken, however, that holes are not started or "collared" dry. To date no workable device is available for removing dust in dry drilling in underground mines.

The places where men work, especially the face region and at ore-dumping or -loading chutes or other possibly dusty places, should be adequately ventilated by constantly flowing currents of fresh, or at least dust- and gas-free, air to remove from the atmosphere breathed by workers any dust or gases that may arise from blasting, drilling, timbering, mucking, or other activities of the workers or of machinery or equipment used by them.

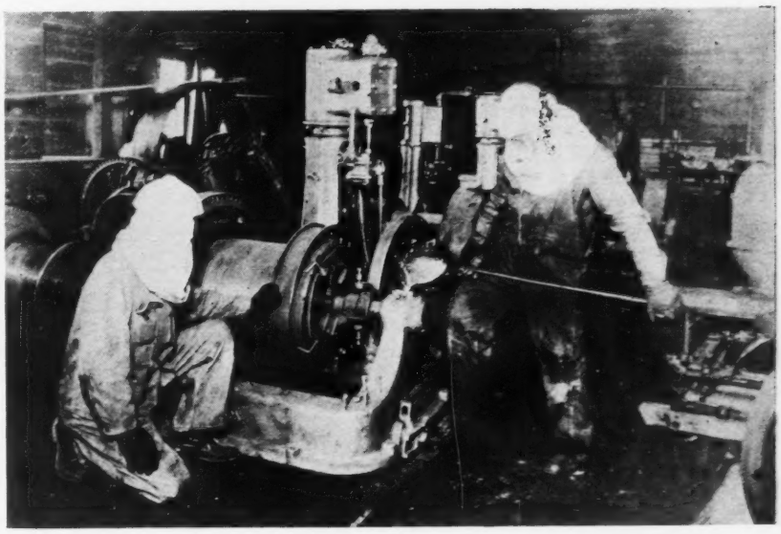
To have adequate ventilation, it is almost a necessity to have mechanically induced ventilation in the form of a modern fan, preferably located on the surface and so arranged as to permit readily reversing the direction of air flow in case of emergency, such as a fire. A ventilation system is, however, essentially worthless unless the air brought into a mine is kept under control and is conducted to the faces and places where men work.

Many metal mines could well afford to adopt the duplicate opening system of coal mining to keep adequate quantities of moving air reasonably close to the face, and certainly every metal mine should have at least two openings to the surface for safety as well as for ventilation; in any event, fan tubing systems can and should be used to remove or dilute air-borne dustiness or smokiness from or at working faces, but utmost care should be taken to prevent recirculation of air or transmittal of already polluted air. Under some conditions exhaust systems may be advantageous; in others force systems; and in many cases a combination of both, or rather use of the one alternately with the other, is advisable and feasible.

Most metal mines should use the split system of ventilation of progressive coal mines in which each mine is divided into sections and each section ventilated by itself, with removal of the return or vitiated air, often highly charged with finely divided dust, from each section to and through separate airways. This prevents to a large extent forcing workers in one part of a mine to breathe air vitiated by workers or working processes in other parts of the mine. Adequate air splitting has numerous advantages in conducting ordinary operations and in case of emergency, such as a fire, in addition to aiding materially in the prevention of dust disease; and several modernly operated metal mines now have effective air-splitting ventilation systems. If air-splitting is not done, the metal mine operated with any regard to the health of the workers will be well provided with water blasts and sprinkling or wetting agencies, and will have working practices designed to hold air-borne dust to a minimum.

Dry, downcast shafts as well as tunnels or inclines that carry air into the mine from the surface and also act as haulage roads should be kept well sprinkled by suitably placed sprays or water blasts or otherwise treated to prevent the incoming air from being highly impregnated with dust. Surface

WETTING DOWN the muck pile to keep the dust down. The machine man has connected the air hose to the water line for this desirable preliminary to his shift's work



FUME as well as dust must be guarded against in mine work. Here in a confined hoist room the workmen pouring babbitt are provided with hoods for their protection

ore bins, crushers, mills, or other dust-producing places or processes should be removed, so far as feasible, from the vicinity of mine openings that take air into the mine, as it is manifestly poor policy to send dust-impregnated air into a mine.

Water should be used in drilling and in sprinkling mine walls, floor, timbers, muck piles, ore and waste chutes, and other dust-making or dust-disseminating places or processes. No dry drilling should be allowed at any time or for any purpose in any underground metal mine, unless possibly where the drilling can be done with an auger. The use of some device, such as a dust trap, with dry drilling ordinarily will prevent air-dustiness from drilling, but unless enough provision is made to assure that the non-use of water at the face does not result in excessive occurrence or dissemination of dust from blasting, mucking, hauling, and other processes, the net result is likely to be an increase rather than a decrease of air-dustiness. At present, no effective substitute for water is available in metal mining to hold air-dustiness within safe limits at the face region.

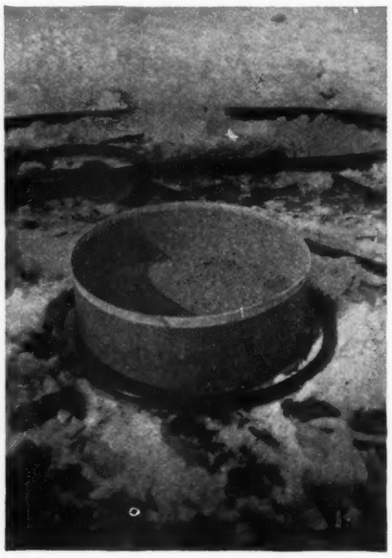
No blasting should be done during the working shift, as, next to dry drilling, blasting is likely to be the dust producer in mining. After blasting any region in which blasting *is* done with men on shift, the place should be definitely cleared of smoke, fumes, and air-borne dust before men are allowed to return to work, and the first duty of the workers on returning to the blasted place should be thorough wetting down of the entire region, including the muck pile.

Good practice makes it advisable to wet down the face region before blasting, especially if men are in the mine during blasting; and in many poorly ventilated metal-mine faces water blasts throwing a finely divided spray of water (probably under pressure with compressed air) should be kept within such distance as to be protected from flying particles from the blast. The water should be started before blasting, continued in operation during the blasting processes, and kept in operation for a considerable period after blasting. Even then men should not be allowed to return to the place that has been blasted until at least half an hour has elapsed.

Utmost care should be taken in the selection, storage, and use of explosives to see that a minimum amount of harmful gases is made in blasting, as there is good reason to think that the breathing of even minute quantities of some gases given off in blasting has definite unfavorable health features to those who breathe dusts.

Crushing ore underground at or near downcast air shafts is decidedly poor policy from the point of view of the health of the workers, and underground crushing should be avoided; but where underground crushing operations are in use, the region around them should be adequately protected by water sprays, water blasts, or other methods of settling or filtering dust out of the air, to insure that dust is absolutely removed from the air after it leaves the crushers and before it reaches the workers.

Where for some good reason it is not feasible to reduce air-dustiness to reasonable proportions, and whenever one can *see* dust in the air, no further test is needed to know that dangerous dust conditions for breathing of workers are probably present. Numerous



FINE DUST, several pounds in weight, that would have filled the air around the machine man had it not been sucked away by a collecting device as fast as made. Here it is seen in the base of the collector's filter chamber

makes and types of dust respirators are available which, though not comfortable to use, give protection and should be worn. However, the wearing of respirators is usually conclusive evidence of failure on the part of management to utilize effective means of eliminating the dust menace to the health of its workers.

Unquestionably, much ill health, including dust disease, of mining people is due to unusual and unnecessary amount of exposure to extremes of heat and cold, complicated with sudden changes from one extreme to the other, with little or no protection from attendant or resultant bronchitis, pneumonia, and related diseases. The mining engineer can and should do much to eliminate those hazards, and this can be accomplished by giving much more attention in future to safeguarding workers from undue exposure to dusts, gases, high temperatures, water, and similar discomforts in transporting them into and out of the mines; by giving real attention to air-conditioning of mines, especially in and at the working places; and in the construction and maintenance of up-to-date types of wash or change houses. These items have been looked upon largely as "frills," when, as a matter of fact, they are necessities if the so-called "racket" in connection with occupational disease is to be combated with a reasonable measure of success.

Before any worker is employed he should be given a careful physical examination by a competent doctor (and the examination should be thorough and the doctor competent). If he is found affected with any respiratory disease, especially tuberculosis of the lungs, he should not be employed for any work in which dust in any considerable quantity is more or less continually in the air of the working place. This procedure is frequently resented, but it is not only justifiable but should be made mandatory to protect the worker, the employer, and the general public.

All persons employed in work of a dusty nature or suspected of being dusty should be given a physical examination at least annually, and any person found afflicted with respiratory disease should not be allowed to continue in dusty work, though justice demands that such men should be given other employment and at essentially the same rate of pay unless it can be proved that the incapacity, trivial or serious, is due to employment previous to that in which they were engaged when the respiratory trouble was found; and it is imperative that precautionary measures should be taken to prevent data from physical examinations from being used unfairly by employers, employees, or others.

Much should be done to clarify numerous uncertainties as to air-dust harmfulness before trying to establish more or less rigid air-dust standards by legal means. At present there is a definite lack of knowledge as to the size of air-borne dust likely to be harmful, and present-day so-called standards of air-dustiness are built on numerous uncertain premises on this point alone. Different authorities find varying maximum and minimum sizes of dust in lungs of deceased silicotics, ranging from as small as 0.2 micron to as large as 10 microns, and from this fact it is deduced that as far as lung harm is concerned the dust to be avoided is that from 0.2 to 0.5 micron on the low side to 6 or even as high as 10 microns on the high side. This leaves much leeway, because an air-dust sample containing 10,000,000 particles (0.5- to 6-micron size) per cubic foot of air might easily have 30,000,000 particles 0.2 micron to 10 microns in size. Moreover, if the solu-

tion theory of dust harmfulness to the lungs is correct, there is good reason to think that particles much smaller than 0.2 micron are very likely to be harmful. To hold that the only harmful dust sizes are those found in the lungs is anything but good reasoning, because it is certain that dusts from 10 to 100 or more microns in size when floating in the air are drawn into the nostrils and other protective air passages, and if in large numbers they soon clog these protective agencies and passages, permitting practically free unobstructed entrance of the so-called harmful dusts (say 0.2- to 10-micron sizes) into the lungs to perform maximum injury. It does not seem to be logical to disregard these larger sizes entirely, as is now done almost universally in the so-called dust standards being considered and announced.

The present-day instruments and methods for sampling air-borne dust and making the determinations as to number of particles present are not accurate or definite, even when handled by technically trained experts; and methods or instruments applied to certain industrial conditions are wholly unsuited to others. A condition as to air-dustiness found in one sample in a certain place is unlikely to be similar to another sample taken immediately afterward in the same place and in the same manner, and this is true where the sampling is done instantaneously by grab method or over a period of several minutes. In other words, the technic as to quantity particle determinations in air-dustiness is not definite, accurate, fair, or dependable, not only as to conditions as between different plants but even as between different time periods in the same place in any one plant. With all of these, as well as numerous other, uncertainties as to air-borne dust, it seems to be a travesty on justice to try to embody in laws, and regulations having force of law, rigid standards as to air-dustiness. If quantity standards covering air-borne dust are made they should certainly be labeled tentative, and the technic of taking the air samples and making the particle determinations should be very carefully outlined and enforced. Otherwise much injustice can be inflicted through inexperience or the malice of the persons making the determinations.

At present it is evident that the legal aspects of dust and its health effects are being accentuated long before fundamental knowledge on which to base the laws or regulations has been developed, and unquestionably some of the laws or regulations recently put into effect or soon to be enacted will require considerable amendment or alteration when really dependable data are at hand. Meanwhile, numerous agencies, committees, and commissions are working on the manifold ramifications of the problem, and much research work is being done not only in laboratories but also in the mines and other industrial plants.

The Bureau of Mines is conducting laboratory work on numerous phases of the subject, but particularly in trying to evolve suitable methods and equipment to determine air-dustiness that will be applicable to mines and mining. Field investigations by the Bureau of Mines, as well as by individual mining companies, are also under way in connection with adaptation of wetting methods in drill holes, mine surfaces, roadways, and working places in general; the effect of sharpness or dullness of drill steel on air-dustiness; use of water blasts and mists with or without oil to reduce air-dustiness; air-dustiness with use of wet drills with and without compressed air going through the drill steel, as well as the effect of lack of repair of wet drills on air-dustiness; application of air-conditioning methods in reduction not only of air temperature and humidity but also of air-dustiness; rotation of workers from dusty to less dusty occupations from time to time; application of exhaust hoods, cloth, and other filters to mining in attempting to reduce the dust content of the air breathed by workers. These and numerous other research problems of an engineering nature are being studied; and, after all, if the dust menace in mining is to be solved, the solution rests largely in the hands of the engineers and operating men in providing "conditioned" air to workers in and around mines.

In a recent report (November, 1936) on preventive engineering in connection with air-dustiness, by a committee composed of well-known dust experts, occurs the following:

"It would be well to realize that men working in dusty trades suffer far more from respiratory troubles of all kinds than do men who work in clean air. The evidence that excessive dustiness of any kind is harmful is beyond argument."

In addition to calling attention to the probable harm to health from excessive dust, it might well be added that air-dustiness has numerous harmful features aside from those which affect health. One is the fact that dusty air very greatly reduces visibility, and in the dust storms in the Dust Bowl early in 1936 visibility at times was reduced to practically zero in midday. A coal-mining study shows that visibility was reduced 75 to 90 per cent during the operation of certain dusty underground processes, and when it is taken into consideration that the underground worker's lighting facilities are poor at best, and that frequently he is working under surroundings that ought to have maximum light if he is to protect himself adequately, this heavy reduction of visibility due to dusty air should in itself be sufficient reason for directing maximum effort against occurrence of dust in air in any place where people must work.

Unquestionably one of the main safety, efficiency, and health problems confronting our mining men is eradication of dust from mines or mining plants or of diminishing or diluting it to such an extent that it will not be a menace to the mine or plant and the workers therein.

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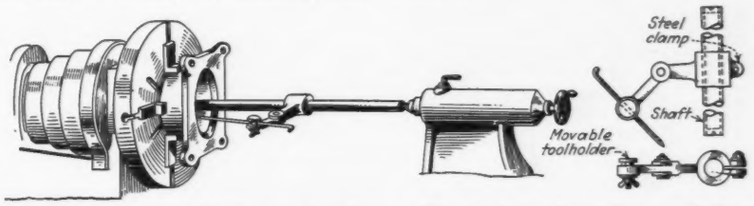
Simple Indicator and Marker Tool

THE simple tool explained in the accompanying sketch has proved effective in reducing the time required for setting work with rough exteriors on the faceplate of the lathe, according to Sidney W. McLeod, master mechanic at a gold-silver mine in Peru. Before adoption of this device alinement of large pump parts preparatory to reboring internal valve seats or piston guides always presented difficulties to the native machinists.

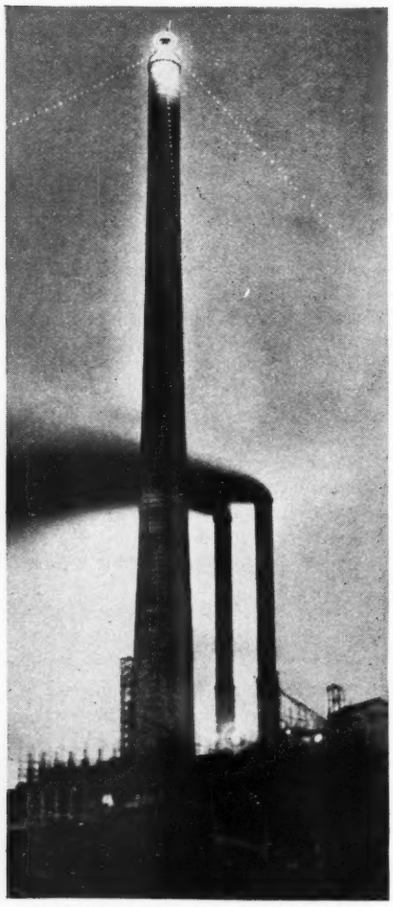
Usually, variations in the truth of the revolving work were detected either with the aid of a steel feeler secured to the toolholder on the compound rest of the lathe, or by simply advancing periodically a piece of chalk to the revolving surface when the valve seat or flange recess was comparatively shallow. Both methods are time consuming, and the latter is also unsafe.



The tool consists of a carefully machined short piece of shaft made from steel pipe resting between the live and dead centers of the lathe and a steel clamp with fork extension in which operates a short steel lever containing at one end a movable holder for the steel marker or feeler proper. The device can also be used for marking finished surfaces on the work piece interior.

Another **Lofty Smelter Stack** For Japan

Nippon Company Erects a 618-Foot Concrete Chimney



THE NEW reinforced concrete stack of the Nippon Mining Company, at Chinnampu, Chosen

ERECTION of what is said to be the tallest chimney in the mining industry, if not in the world, was completed last September at the Nippon Mining Company's smelter at Chinnampu, Chosen. This stack was built according to the system of the Weber Chimney Company, of Chicago, by a contractor, the Oriental Compressol Company, of Tokyo. Built of reinforced concrete, it is 618 ft. high above the bottom of the foundation, which is 18 ft. high. The foundation is circular and 97 ft. in diameter. At the top the inside diameter of the chimney is 25 ft., the thickness of the shaft wall here being 7 in., as compared with 37 in. at the bottom. The shaft is lined for 180 ft. with reinforced concrete, 6 in. thick. This lining the Weber company uses as standard where the temperature of the gases is not extremely high. Between the lining and the outer shell is a 4-in. air space.

The foundation contains 3,200 cu.yd. of concrete of a 1-3-5 mixture and 120 tons of steel bars. Concrete used in the shaft is a 1-2½-3 mixture and its reinforcement consists of vertical bars and horizontal rings, comprising in all 320 tons of steel. The upper part of the inside of the stack is covered with bitumastic paint.

Although the foundation was built during the fall of 1935, no attempt was made to build the shaft until the spring of 1936. It was started about March 15 last and completed on Sept. 18 to its height of 600 ft. above the foundation. In all, construction of the foundation required about one month and of the shaft five months. No accidents occurred.

The Nippon Mining Company is owned by the same interests as the Kuhara Mining Company, for which the Weber company built the lofty stack at Saganoseki, Japan, over twenty years ago, then the world's tallest. The Saganoseki stack, as described in *E. & M. J.*, Nov. 18, 1922, page 903, is 550 ft. high and 27.5 ft. in diameter at the top.

In comparing chimneys, however, one must consider other dimensions besides the height. For example, Anaconda has a stack, built of perforated brick, that is 585 ft. high and 75 ft. in diameter at the bottom and 60 ft. at the top. The smelter at San Luis Potosi, Mexico, placed in operation last year a reinforced-concrete stack that is 520 ft. high above its foundation and 44 ft. in inside diameter at the bottom and 30 ft. at the top. (See *E. & M. J.*, April, 1936, pages 182 and 184). Likewise in 1936, the International Nickel Company of Canada placed a third large stack in service, at Copper Cliff, Ont., the new one being of reinforced concrete, lined with firebrick, 550 ft. high over all and 500 ft. above the foundation, with an inside diameter of 55 ft. 9 in. at the bottom and 40 ft. at the top (See *E. & M. J.*, September, 1936, page 454).

In the accompanying photograph of the Chinnampu stack, two smaller reinforced cylindrical concrete chimneys are seen. These are of a type no longer built by the chimney company and are to be demolished, if this has not already been done. The picture also shows an illuminated sign at the top of the new stack, as well as strings of electric lights running from the ground to the top, which were used in the course of celebrating the completion of the work.

▼ ▼ ▼

Obtaining Beryllium From Beryl

PRODUCTION of beryllium from its ore, beryl, is complicated by the fact that beryl in its natural state is not easily attacked by chemical reagents. One method of procedure is revealed in the specifications of United States Patent No. 1,823,864, granted to Charles B. Sawyer and Bengt Kjellgren, and assigned to the Brush Beryllium Company, of Cleveland, Ohio. The crux of this invention lies in so modifying the physical properties of beryl by melting it, and quenching the molten material in water, that it is readily susceptible to chemical attack. If the melt is treated with sulphuric acid, for example, beryllium is converted into the sulphate which is soluble in water. The extracted yield is about 90 per cent in terms of beryllium oxide.

Briefly, beryl is melted at 1,500 deg. C. to 1,600 deg. C., quenched in water, and ground to 200 mesh. It is then heated in an open vessel with 63 deg. Bé. sulphuric acid, although the chemical activity can be increased if the reaction is carried out under pressure. The sulphated material is broken up and leached with water. Silica and other insoluble material is filtered off. The filtrate contains beryllium and aluminum sulphates, which can be separated by converting the latter into ammonia alum by the addition of ammonium sulphate. The alum is separated by crystallization and filtration. Beryllium sulphate is crystallized from the filtrate, several crystallizations being necessary to free it from iron. The beryllium sulphate can then be converted into oxide by heat, which is available for conversion into fluoride or chloride for subsequent electrolysis.

Roasting "Blue Ores" At the Maitland Mine

Highly Refractory, These Siliceous Gold Ores of the Black Hills Require This Treatment Prior to Cyanidation . . . At That, the Extraction Approximates Only 85 per Cent

L. B. Eames
General Manager, Canyon Corporation
Deadwood, S. D.

Roy Van Zante
Mill Superintendent, Canyon Corporation
Deadwood, S. D.

BODIES of what is known locally as "blue ore" remained in the Maitland mine, in the Black Hills of South Dakota, when the milling operations which had been started by the North Homestake Mining Company in 1903 ceased in the spring of 1909, because the known oxidized portions of the orebodies had become exhausted. The blue ores could not be treated by the milling method then in use. They were in most cases of good grade but of extremely refractory nature. A recent test by direct cyanidation on an ore similar to that occurring in the Maitland mine gave an extraction of only 16 per cent. The ordinary microscopic examination of the ore will not reveal the presence of free gold. Amalgamation, gravity concentration, and flotation have all given no hope for the successful treatment of the ore by these means.

The ore occurs in a sedimentary formation of Cambrian age, locally known as the Deadwood formation. The ores at Maitland are near the lower contact, being but a few feet above the Pre-Cambrian schists. The ore was formed by the replacement of a dolomite bed, locally from 3 to 12 ft. thick but normally about 5 ft. in thickness. Where ore occurs, the dolomite has been silicified; but considerable areas of unaltered dolomite remain which are practically barren. It is thought that the silicification resulted from solutions ascending through the schist through fractures mainly parallel to the practically vertical schistosity. Another set of fractures in the Cambrian rocks cross at an angle of 20 to 60 deg. to the fractures in the schist. These appear to have influenced the distribution of the solutions, with the result that the orebodies have very irregular shapes. The ore seems to be limited in extent to a relatively small distance from one or the other of these sets of fractures, intersections being most favorable.

The physical nature of the ore resulting from these conditions is of importance. Where the action has been most intense, the replacement seems to have been complete and the ore is extremely hard, scratching glass easily. Pyrite was also deposited with the silica, so that the ore averages 5 to 8 per cent sulphur. Other elements are present in varying amount. Arsenic occurs, but arsenopyrite has not been identified. Tellurium minerals have been identified but are probably not significant from the metallurgical point of view.

In Bulletin 16 of the South Dakota School of Mines, Messrs. Connolly and O'Harra stated: "Pyrite is always present in the blue ore. . . It may not be apparent to the unaided eye, and in some specimens only the microscope will reveal it, but it is universally present. It is the finely disseminated pyrite that gives the bluish-gray color to the ore." The most powerful microscopes cannot determine the minimum size of these pyrite crystals. They are generally disseminated, rather than occurring in streaks or bands. Under the microscope they look somewhat like stars in the sky.

It is probable that most of the gold is associated with the pyrite. At any rate, the Canyon Corporation, which is now operating the mine, has been able to produce an insoluble residue which assayed only a trace by extraction with aqua regia. A further peculiarity of the ore is, that of the six-mesh product prepared for roaster feed, the coarser sizes are higher in grade than the fine; and in the reground cyanide tailing, the coarser sizes are lower in grade than the minus 200-mesh portion.

Large tonnages of oxidized ore of apparently identical origin have been mined in this district. Due to more favorable location, or in some cases perhaps to less dense structure, these have been oxidized by nature. Even these ores have not yielded as high an extraction as is usually realized—rarely over 85 per cent.

Extraction approaching that obtainable on the naturally oxidized brown ores by direct cyanidation can be obtained on the blue ores by roasting and cyanidation. The process now used is as follows:

The ore is delivered by the mine cars to a No. 5 Gates gyratory making a 2-in. product and the crushed product is elevated to a cylindrical steel bin of 180 tons' capacity. A drying and crushing plant, consisting of a rotating cylindrical dryer, a 2-ft. Symons crusher, a chain bucket elevator, and 16x42-in. rolls in closed circuit with a 3x5-ft. Link-Belt vibrating screen, reduces the ore to minus 6 mesh. This then goes to a second steel bin, from which it is fed to the roaster.

As originally designed, the roaster gases were conducted through the dryer, and thence to a stack. This arrangement proved unsatisfactory because of the openings in the flue necessary to feed and discharge the ore. There were also leaks at the joints between the rotating dryer and the stationary flues. These openings admitted so much cold air that the draft at the roaster was insufficient. Overdrying resulted, which produced excessive dust loss and almost impossible working conditions. This was remedied by removing the flue connecting the roaster to the dryer. Two gas burners were installed in the dryer and an independent stack was provided for the roaster.

Now an effort is made to dry sufficiently for crushing and screening but

to leave enough moisture to keep the dust at a minimum by regulating the dryer burners. The separate roaster stack provides a draft of about one-tenth inch water gage.

The Symons crusher is set to deliver a $\frac{3}{8}$-in. product. To keep the circulating load within the capacity of the elevator and screen, it is necessary to set the rolls very close. By constant attention to the feed distribution and the fleet adjustment of the rolls, the shells are worn down evenly until they become so thin that they crack.

A constant-weight feeder delivers the minus 6 mesh ore to a 54-spindle Edwards roaster, with a 13x112-ft. hearth, which is fired with natural gas at 10-lb. pressure. The normal gas consumption is about 1,550 cu.ft. per ton of ore, of gas averaging about 850 B.t.u. per cubic foot. The fuel cost under our conditions is materially less than it would be with either coal or oil.

The roaster discharges directly to a Baker cooler and the cooler discharge is sluiced directly to the fine-grinding circuit with mill solution. A bin for the roasted product would have been desirable, but in the alteration of an old plant, the provision of this was difficult to accomplish.

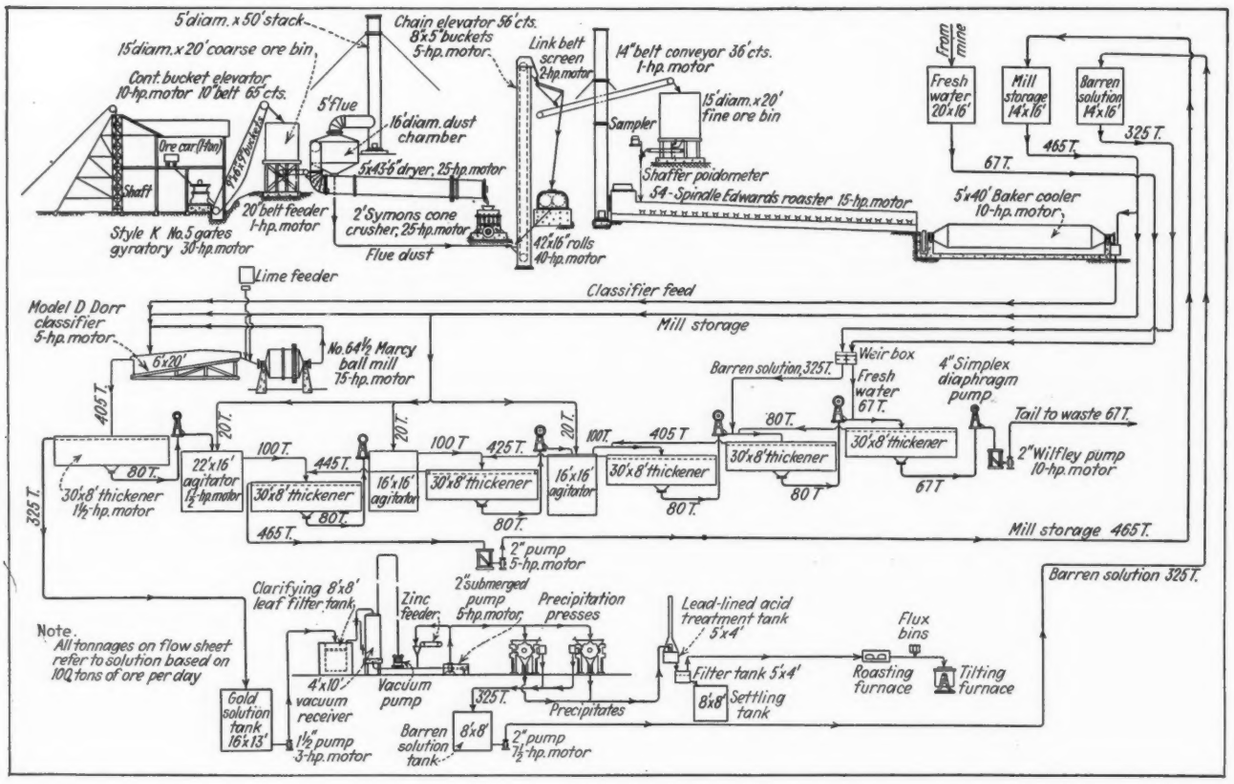
Gas burners are placed on each side of the roaster, between every second spindle for two-thirds of the furnace length. There are no burners at the feed end. Originally, there were four burners in the discharge end wall, but these were discontinued. The desired time-temperature curve is now attained by using six burners on a side near the center of the furnace. Natural gas as fuel has been very satisfactory wherever it has been used in the plant, but has been particularly valuable at the dryer and roaster, where close temperature regulation is necessary.

Seven thermocouples are spaced at intervals on one side of the roaster and one thermocouple is provided for the flue chamber. They are connected through a multiple-pole switch to a potentiometer, so that temperatures throughout are easily determined. The thermocouples along the sides pass through the side wall into the ore bed itself, close enough to the path of the outer end of the rabble so that fresh ore is swept over or very close to the tip of the thermocouple at every revolution.

To get a good roast, characterized by the typical red Fe_2O_3 color, we believe that it is necessary first to convert the sulphides to sulphates by a relatively long period of gradual temperature increase, followed by a short period with the temperature above the decomposition point of iron sulphate, to break down these sulphates to Fe_2O_3. Without difficulty in the laboratory, but not so easily in practice, it is possible to raise the temperatures so fast at the start that the sulphates are not formed. The iron then passes directly into some lower oxide and the calcines have a dark color. If the ore is subjected to this high initial temperature, it is impossible by any subsequent heat-treatment to convert these dark oxides to Fe_2O_3. A roast of this dark appearance yields lower extraction and consumes more cyanide.

One should bear in mind that there may be in the coarser sizes fed to the roaster a large number of pyrite crystals that are entirely sealed in silica and that the reactions to which these particles are subject are different from those occurring in the exposed pyrite crystal. Pyrite is said to yield on distillation without access of air, a sulphide corresponding to pyrrhotite. Microscopic examination of our tailing has shown that the sulphides exist in our tailing and that these sulphides were reported as pyrrhotite. A substantial part of this value can be floated out and would presumably yield to a re-roast, but this procedure has not been thought to be economically justifiable.

In line with this theory, current practice is to bring the ore gradually to a 600 deg. C. maximum in two-thirds of the length of the roaster and allow it to cool to about 300 deg. C. in the remaining distance. This maxi-



THE FLOWSHEET of the Canyon Corporation's mill at Maitland, S. D. Roasting is an important and vital feature of the treatment. The practical capacity of the Edwards unit is about 110 tons daily

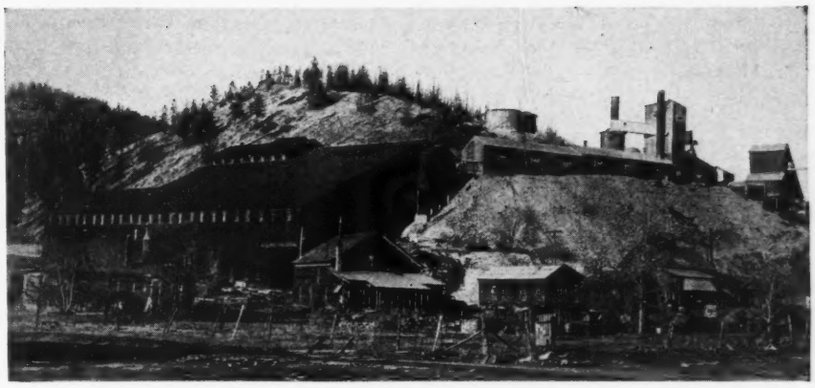
mum temperature is well above the decomposition temperature of iron sulphate and exceeds the temperatures which were used in the Bureau of Mines tests that yielded the best extraction. But this test work showed a lime consumption of 40 lb. or more per ton of ore and made it appear that a preliminary lime-water wash was necessary. By decomposing the greater part of these water-soluble sulphates in the roaster, the lime consumption has been reduced to 14 lb. per ton of ore. The ore is milled successfully without a preliminary wash and comparable extractions are obtained. Cyanide consumption is about one pound per ton of ore.

Little mechanical difficulty is experienced with the roaster, and when repairs are necessary they are quickly and easily made. Spindles weigh 95 lb. and the rabbles 210 lb., without shoes, and are changed from the top of the roaster without need for cooling it down. The rabbles are all identical in design, but the first fourteen are not water-cooled. The plant has mechanical capacity for at least 125 tons, but 110 tons seem to be the practical limit of the roaster for our sulphur content. Going beyond this figure seems to exceed the capacity of the roaster for eliminating sulphur, and a drop in extraction results.

The fine-grinding department consists of a Model D Dorr classifier in closed circuit with a No. 64½ Marcy ball mill, without grates, using 2½-in. steel balls. As the feed to this circuit is not variable, because it takes the calcines as they are discharged from the roaster, the ball charge is regulated to maintain a high circulating load for whatever tonnage the roaster delivers. A grind of 75 per cent through 200 mesh is made. From here, as the flowsheet shows, the treatment follows conventional cyanide practice, with perhaps a few unusual features.

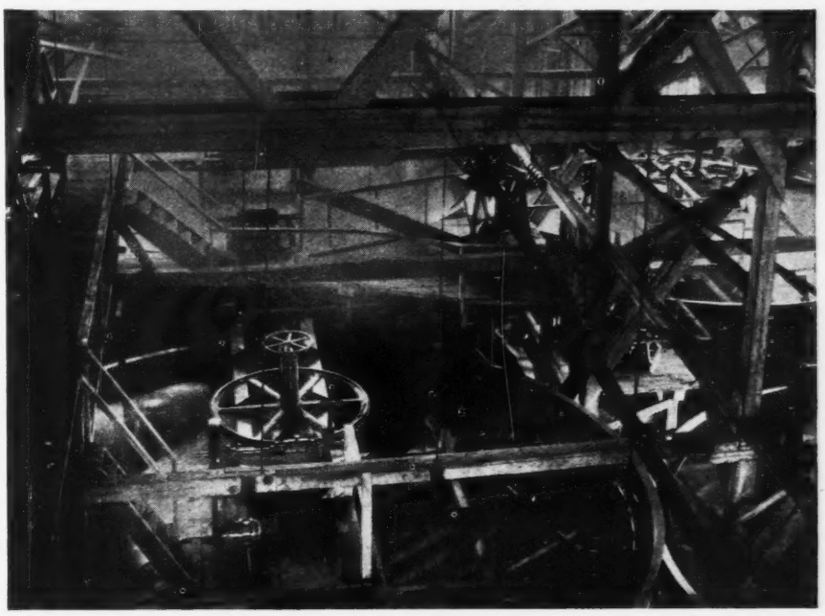
The first agitator discharge is diluted and rethickened before proceeding to the second agitator; and, similarly, the discharge of the second agitator is diluted and rethickened before passing to the third agitator; which gives, with the primary thickening, three changes of solution with the three stages of agitation. This frequent change of solution is very beneficial. Laboratory tests as well as mill practice prove that when solution has been in contact with the calcines in an agitator a certain length of time, the solution loses its dissolving power and the values will dissolve no further without change of solution.

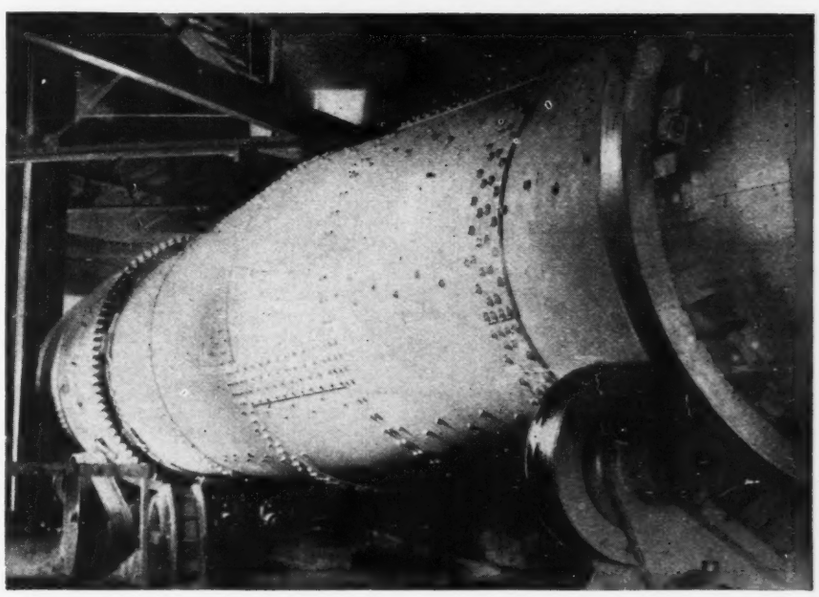
The third agitator discharge passes through three thickeners in countercurrent decantation with no filter following. By careful attention to the thickness of the underflows and a 3-to-1 barren wash, the dissolved value



THE MAITLAND MILL of the Canyon Corporation, in the South Dakota Black Hills. The plant houses equipment for drying, roasting, and cyanidation

THICKENERS in the Maitland mill. There are six 30x8-ft. units in all. They provide almost 6 sq. ft. of settling area per ton per 24 hours. Bottom—ROTARY DRYER fired with two gas burners, regulated to dry the ore sufficiently for crushing and screening but to leave enough moisture to prevent excessive dusting





loss is kept reasonably low, although continued dissolving of values through the final thickeners brings it up somewhat. The pulps are transferred by standard diaphragm pumps having a maximum lift of 3½ ft. After eighteen months' operation, the six original diaphragms are still in use.

This ore, being completely dehydrated in the roaster, settles rapidly, and underflows of 55 to 60 per cent solids are obtained without difficulty. The thickeners provide almost 6 sq.ft. of settling area per ton per 24 hours. The overflows are always clear, and it is thought that, under these conditions, 4 sq.ft. might be sufficient.

Precipitation is accomplished in ordinary Crowe vacuum apparatus followed by two 36-in. Merrill presses. Up to 400 tons per 24 hours of solution is clarified through fifteen vacuum filter leaves, each having an area of 60 sq.ft. The life of the leaves is short, for a reason to be given later.

The principal operating difficulty is caused by calcium sulphate. Small amounts of water-soluble sulphates are unavoidable in the roaster discharge. When these sulphates come in contact with the lime in the solutions, this compound is formed. Any unaltered dolomite in the ore may also form calcium sulphate in the roaster. At times the capacity of the solutions for maintaining this in solution is exceeded and large quantities crystallize out. This material after a time closes up pipe lines, making it necessary to tear them down and clean them out. It cements pulp around the circumference and around the center column of the agitators, making it necessary to blow the accumulation off each day with high-pressure air to avoid big masses caving in and stalling the mechanism. If the rate of discharge of a thickener is a little slow for a few hours and a layer of pulp is held in the tank, cementing action of this material causes islands to form on the rakes. The thickeners are blown daily with high-pressure air to avoid sticking them from this cause. Quantities of these crystals accumulate inside the clarifying leaves, making it necessary to renew them frequently; also behind the press cloths and in the passages on the plates of the precipitation presses, lowering the filtering capacity. Once in a while, this material must be scraped out. Sometimes when a particularly large amount is thrown out, it deposits with the precipitates, making them impervious to acid-treatment. It is suspected that it coats the zinc dust, making it less effective, and makes the use of extra amounts of zinc necessary; and further, makes it necessary to remove this zinc by acid-treatment before melting. It is also suspected that one of the reasons the gold is slow to dissolve is because of a coating of this material.

On account of the difficulties encountered elsewhere from calcium sulphate, great difficulty would probably be encountered in operating a tailings filter. Cloth life would be short; pipes would plug, and the elimination of a smaller amount of the solution laden with calcium sulphate from the mill circuit each day would increase the deposition in other parts of the mill.

The acid-treated and roasted precipitate is melted in a standard tilting furnace to produce bullion of over 900 total fineness.

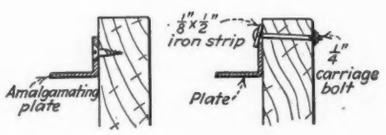
Cost of operation is naturally increased by the introduction of roasting. The roasting step introduces an additional cost averaging about 55c. per ton, of which about one-half is gas; but the necessary drying and fine crushing also involve increased costs. If a dry rod mill had been used in place of the rolls, a somewhat finer grind could probably have been realized, or at least one containing less oversize. Maintenance would have been materially reduced. If, in addition, the dry-crushing time could have been reduced to one shift, still further economies would have resulted.

Other costs are about in line with those of similar operations on this scale.

▼ ▼ ▼

Fastening Amalgamating Plates

COPPER amalgamating plates are usually fastened by nailing or bolting a cleat over their edges to hold them down and prevent leakage. This method, however, is not free from objections, writes Charles Labbe, of Goldfield, Nev., who suggests turning the edges up and fastening them to the side with wood screws or small carriage bolts, thus giving an angle that is easier to dress and clean. A narrow strip of rubber can be inserted between the plate and the wooden frame, preventing leakage. The plate does not tend to buckle and the loss in area is about the same, or perhaps less, than with the older style.

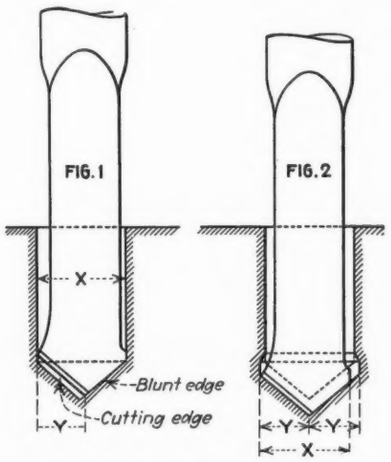


To do the bending neatly, the plate should be clamped between a piece of timber and a rail and the edge bent over with a mallet or with a hammer and a block of wood. To prevent scratching the silver plating, old cloth or newspapers can be wrapped around the rail. The sides can be bolted directly to the frame or the edge can be covered for its entire length with a strip to ⅛x½-in. flat or half-round iron.

Enlarging the Bottom Of a Drill Hole

ONE of the most tedious jobs frequently performed at the mine, mill, or smelter machine shop is tapping holes for studs in equipment such as pump chambers, presses, and different compressor parts. To insure a tight stud the threads must be cut to the bottom of the drill hole, which is a relatively easy task when the holes to be tapped are small. Difficulties arise, however, when the diameter of the hole exceeds 1 in. and when only standard tools are available at the shop.

At a large silver mine in Central Mexico tapping of large drill holes has been speeded up more than 40 per cent by enlarging the bottom of the hole with the special drill explained in the accompanying line cuts. As will be seen, it is an "off-center" drill with a cutting edge and a blunt edge. The width of the drill should not be larger than the diameter of the hole, or *X*, and the radius *Y* of the enlarged hole below diameter *X* must correspond with measurement *Y* of the drill.



Detail of special drill for enlarging the bottom of a drill hole, as developed at a Mexican silver mine

The method of operation is shown in Figs. 1 and 2. At the start of drilling operations the blunt edge of the drill rests upon one side of the incline bottom of the hole as in Fig. 1. This is followed by first starting the drill press at slow speed and then slowly advancing the drill spindle until the position shown in Fig. 2 is reached. Thereafter the enlargement at the bottom of the hole can be drilled to any depth desired.

Blasting Accidents Can Be Eliminated

Eighteen Typical Mishaps and How to Avoid Them

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W. J. Williams
Safety Engineer, Phelps Dodge Corporation, Morenci Branch, Arizona

ACCIDENTS that occur in the course of blasting, though low in frequency, rank with the highest in severity. They are the most difficult to investigate, as they too frequently result in fatalities, and by their very nature have a tendency to destroy all evidence of their origin. The survivors of a blasting accident are often of little use in an investigation; so suddenly does the accident happen and so overcome by shock are the witnesses, that their testimony is frequently unreliable and at times so distorted that it has a tendency to conceal the real cause of the accident.

How, then, should we proceed if called upon to compile a safety code for the handling of explosives? As one method of approach, a careful analysis of actual blasting accidents was made. In making this study or analysis, we were prepared at all times to keep an open mind and be ready to discard some of the traditional blasting rules, should our analysis prove them to be inadequate.

In the formulation of a safe blasting code, all of the blasting accidents at a typical Southwestern metal mine over a period of twenty years were reviewed and studied. These accidents were grouped, so far as possible, according to type. Each type was then analyzed and every possible cause of that type of accident listed.

When, through a careful analysis, all of the possible causes of each type of accident had been determined, the most difficult part of the study was completed. Following this, it but remained to set up opposite each type of accident a method of procedure, which, if faithfully followed, would eliminate every possible cause of that type of accident. These safe methods of procedure, written in the form of rules and systematically arranged, gave the desired blasting code.

In the analysis which follows, due consideration has been given to the growing popularity of electric blasting in metal mines during the past few years. Though electric blasting is often suggested as a "cure-all" for all blasting accidents, this statement is true only when electric blasting is performed by properly trained men. Experience has proved that when it is used by men unfamiliar with its hazards, electric blasting may well be as dangerous a method as that of fuse blasting.

In South Africa, the "safety primer[1]" has been in use for some time, but it has been but little used in the United States until recent years. In 1930, the Morenci Branch of the Phelps Dodge Corporation made some experiments with it, and its engineers were so impressed with the convenience and safety of this primer that they adopted it as standard for all their blasting operations. On the Colorado River Aqueduct, in Southern California, where over a hundred miles of tunnels are being driven, the safety primer has been adopted as standard on all Force Account work and also by many of the contractors. Over a million safety primers have been used on this project, without a single blasting accident where the safety primer was in use. One large mine on the California Mother Lode has made exhaustive tests with the safety primer, and has not only found these primers safe, but efficient as well. The safety features of the inert primer have therefore been included in the analysis here presented.

Every blasting method suggested in the following outline has been used under actual working conditions, and has not only proved of a practical value in eliminating blasting accidents, but has often been a means of increasing the efficiency of operations. Eighteen types of accidents are considered in the following paragraphs. They are numbered in order.

TYPES OF ACCIDENTS

I . . . *Firing of the Charge While It Is Being Loaded*

▶ Possible Cause:

1 Poorly made primer, allowing friction of cap with the side of the hole.

2 Tamping with an iron bar.

3 Pounding on the primer with the tamping stick and forcing the blasting cap to the side or bottom of the hole.

4 Attempting to force a primer into a a hole that has raveled.

5 Forcing the primer into a hole that has been incompletely blown out.

6 Spitting the fuse before inserting the primer into the hole.

7 Not cooling holes sufficiently after pocketing.

▶ Suggested Preventative:

FUSE BLASTING: Great care must be taken when making primers. The stick of explosive used for the primer should not be split. The cap should be placed in a hole punched vertically in the end of the stick or diagonally through the side, care being taken that the hole does not pass entirely through. In either case, the fuse should be securely tied to the stick of dynamite. It is also advisable to tape the primer, around that portion containing the blasting cap, with friction tape. Another method is to insert the primer in a section of a mailing tube, slightly larger in diameter than the primer and of the same length.

[1] See *Engineering and Mining Journal*, May, 1935 "Blasting With Safety Primers."

Wooden tamping sticks only should be used, as iron will strike sparks which may detonate the explosive. The iron bar can also crush the primer and thereby come into contact with the blasting cap.

The primer should be pushed into the hole with a gentle pressure. Forcing the primer may push the blasting cap through the paper cartridge, thus setting up friction between the cap and the side of the hole.

Before placing the dynamite or the primer into the hole, the tamping stick should be run the full length of the hole to make sure that no chips of rocks from raveled ground or hard lumps of sludge due to the improper blowing out of the hole with the blowpipe have been left in the hole. It is important that holes be blown out immediately after drilling, regardless of when they are to be shot; otherwise the sludge will harden in the hole, making it impossible to load safely.

Never spit a fuse before inserting the primer into the hole. All fuses should be long enough to reach beyond the collar of the hole; otherwise electric blasting should be used.

All holes should be allowed to cool after springing; if there is insufficient time available for it, flush the holes out with water.

ELECTRIC BLASTING: The safest known primer is the electric blasting cap inserted in a block of wood or other non-explosive material. This is known as the safety primer. In the safety primer, the blasting cap is fastened into a hole in the longitudinal axis of a block of wood, which block of wood is slightly smaller in diameter than the bore of the drill hole and is a little longer than the complete detonator. The live end of the cap comes flush with one end of the block. To load a hole with the inert primer, remove the paper from one end of a stick of dynamite and place the live end of the primer in contact with the bare explosive. Both are now shoved into the hole at once, the primer being placed in the bottom by pushing on the dynamite with the tamping stick. When the primer and the stick of dynamite have reached the bottom, a firm push on the tamping stick will force the dynamite firmly around the live end of the primer. The use of the safety primer is the best insurance against the hazard of firing of the charge while being loaded.

II . . . *Premature Explosion of the Charge*

▶ Possible Cause:

1 Running fuse.

2 Using too short a fuse.

3 Not using tamping or stemming and the burning fuse from one hole spitting into another hole and setting explosive on fire.

4 Not using tamping or stemming in a recharged round and the fuse spitting directly against the new primer, exploding it.

5 A damaged fuse projecting from a recharged round and this fuse being ignited by mistake.

6 Leaving the capped end of the fuse outside of the hole and setting it off with a knife or the open flame of a lamp.

7 Fuse spitting into the explosive of a bomb or of a bulldozed shot.

8 Tying a bomb with the fuse and having the fuse spit across the knot, setting the dynamite on fire.

▶ Suggested Preventative:

FUSE BLASTING: Though under the present system of manufacture of safety fuse the possibility of a running fuse is remote, nevertheless, for the satisfaction of all concerned, every shipment of fuse received should be tested. This test can be made by selecting samples from different cases or rolls and burning them, observing the rate of burning by means of a stop watch. This should check with the manufacturer's rate, within certain limits.

Stemming or tamping must be used in all holes loaded, both for efficiency and safety. Unless tamping is used, the flame from a spitting fuse can spit against the bare explosive in an adjacent hole, thus setting the explosive on fire. (Probably, many cases of so-called running fuses would show, upon investigation, that tamping or stemming had not been used.)

A minimum length of fuse should be established for each type of work. The fuse should always be at least a foot longer than the hole is deep and be long enough to allow ample time to spit the round and then retreat to a safe shelter. Men who practice short-fusing should be disciplined.

In recharged rounds all of the old fuse should be cut off even with the collar of the hole and then the old fuse carefully tucked in the hole ahead of the new charge. Should a section of the old fuse project from the hole it might be spit by mistake, or the flame from the spitting of one of the new fuses might ignite it.

Care must be taken not to use the wrong end of the capped fuse in making the primer, thus leaving the capped end projecting from the hole. The cap can then be exploded by friction when the miner attempts to cut it with his knife, or he may ignite it with the flame from his lamp. (This is likely to happen when capped fuses are dipped into a water-proofing compound of the same color as the fuse.)

In secondary blasting, either by blockholing or plastering, care must be taken to see that the burning fuse does not ignite the explosive. In blockholing, tamping or stemming must be placed in the hole on top of the explosive. In plaster shots, the explosive must be thoroughly covered with mud.

In making up a bomb, or in tying a bomb on a stick, string should be used. It is dangerous practice to use the fuse itself for this purpose, as at the place where the fuse is knotted, the fuse may spit through to the powder or spit across to an adjacent section of fuse, giving the effect of short fusing.

ELECTRIC BLASTING: One of the principal reasons advanced for changing from fuse to electric blasting is the prevention of premature explosions. However, premature explosions may take place with electric blasting unless the proper safety precautions are taken.

Leg wires of the caps should be shorted at the factory by twisting them together or by the use of a patented shunt. These shunts or shorts should not be removed, except for testing purposes, until the round is entirely loaded and ready to wire up.

The entire lead wire should be taken into the face in a roll and one pair of ends kept shorted while the other pair is attached to the leg wires from the loaded round. The lead wires should be unrolled as the miner retreats from the face, supporting the wires upon timber or some other non-conductor as the wire is unrolled.

The first connection to the permanent blasting line must be made in a place that is out of direct line of fire from the face. These same precautions should be followed when blasting from a blasting machine.

To guard against premature explosions due to lightning, there should be an air gap in the main blasting lines of at least five feet. This gap is kept broken at all times except when ready to fire the rounds.

If trolley wires or other power lines lead near the face, they should be killed while loading is in progress. It must be kept in mind at all times, when doing electric blasting, that all wires, pipes, rails, and other metallic substances, as well as all rock and damp timber, carry a certain amount of stray current. It is therefore important that all wires used in electric blasting be properly insulated and that they be provided with shorts or shunts that are removed only when actually using them to fire the blast.

III . . . *Staying Too Long at the Face When Spitting*

▶ Possible Cause:

1 Ignorance of the burning rate of fuse.
2 Faulty preparation of the fuse for spitting.
3 Using too short a fuse.
4 Failure of lamp.
5 One man attempting to spit too great a number of holes.
6 Delay due to spitting in wet places.
7 Delay due to spitting in drafty places.
8 Blinding caused by smoke and fumes from burning fuse.
9 Doing unnecessary work after spitting.
10 Not having a clear retreat from the face.
11 Failure of hoist to take men away from blast.

▶ Suggested Preventative:

FUSE BLASTING: All miners should be instructed regarding the average burning rate of fuse. For example, many miners may think that the average rate of burning of fuse is about one foot per minute, whereas, as a matter of fact, the average rate of burning is about one foot in 40 sec.

All fuse should be split on the end when preparing it for spitting. Many miners have a practice of notching fuse on the side. When being spit, such a fuse is likely to spit on the short end only, thus making it necessary to notch and respit the fuse again. When the fuse is properly split on the end it takes fire easily, and, once spit, it does not have to be watched.

A minimum length of fuse should be standardized for each class of work. A standard practice should be adopted for the trimming of the fuse to insure the proper rotation of the shots.

There must always be the fewest number of men possible at a face when spitting. (Making sure that there are at least two.) Unnecessary men only increase the exposure and make for confusion, and they may distract the attention of the miner doing the spitting.

One man should not attempt to spit more than one round of holes. If two or more rounds are to be spit, or a large number of scattered holes, extra help must be furnished for the spitting.

Only absolutely necessary work should be done in a face after the round is spit. All tools, tamping stick, supplies, extra explosives, etc., should be removed from the face before the spitting starts.

When preparing fuses for spitting, they should be so arranged that the miner will not be delayed while spitting because of smoke obscuring his vision of all of the fuses.

In shaft sinking, where men must be hoisted out with a bucket, the engineer must be warned just before spitting and the spitting must not begin until the engineer has acknowledged the warning by raising and lowering the bucket. The engineer must take no other signal in the meantime and he must be prepared to hoist the men away upon the signal of one bell.

While spitting in a shaft, one man must be stationed at the bell cord to see that it does not become entangled with the cable or bucket.

A chain ladder should be hung from the last set of timber to within five feet of the bottom of the shaft where fuse blasting is used.

ELECTRIC BLASTING: If done properly, this method of blasting eliminates all danger of staying too long at the face. This is due to the fact that the actual firing of the round is done from a sheltered place, out of direct line of fire. Electric blasting should be the only method of blasting ever used in winze, shaft sinking, and long raises.

IV . . . *Unguarded Shot*

▶ Possible Cause:

1 Not guarding all approaches.
2 Guard leaving his post before the shot goes off.
3 Guard hearing another shot and thinking that it is the one he is guarding.
4 Guard thoughtless or absent-minded.
5 Not guarding a connection on the opposite side from the shot.
6 Blasting near an empty chute and failing to guard the top or bottom, or both.
7 Blasting in a hung-up chute and not anticipating the fact that the bomb may become dislodged and fall to the level below.

▶ Suggested Preventative:

FUSE BLASTING: Whenever possible, have the boss in charge of the blasting place and release all guards. All approaches to any blasting area must be either barricaded or guards placed at each of them when blasting. Just because an area is abandoned, is no assurance that persons cannot enter from that direction. Engineers, geologists, and mine officials have a habit of visiting such places.

All guards, when posted, must be warned that they are not to leave their posts until relieved by the same person who placed them there.

Guard the bottom and top of all empty chutes or raises leading to the blasting area. Remember that when blasting down hung-up chutes or fingers there is a danger of the bomb used becoming dislodged and falling to the level below and exploding; therefore, guard the area for a safe distance on each side of a hung-up chute or ore pass that is being shot.

A miner must always be kept informed of the distance he has to go for a connection. When two faces are within 20 ft. of connection, all men should be removed from both and both faces guarded whenever either is shot.

ELECTRIC BLASTING: Shooting with electric blasting simplifies guarding. By this method all firing can be done by the boss after he has checked all men out of the blasting area by means of time cards or checks. Another method is to place a gate or interrupter across the entrance to the working place so that opening this gate will break the electrical blasting circuit.

V . . . *Struck With Flying Rock*

▶ Possible Cause:

1 No allowance made for ricocheting rocks thrown from the blast.
2 Standing in direct line of fire, regardless of the distance from the blast.
3 Not allowing sufficient time to get out of range before the first hole fires.

▶ Suggested Preventative:

FUSE BLASTING: When seeking a safe place for a shelter, while a round is being blasted, it is better for one to stand just around a right angle corner, rather than to stand in a tunnel with more or less long irregular bends. In the latter, rocks have a tendency to ricochet from side to side of the tunnel, often traveling a considerable distance.

A person should never stand in direct line of fire from a shot, regardless of the distance he is away. A blown-out shot may throw small rocks, with the speed of bullets, several hundred feet down a tunnel that is straight.

When cutting fuse, allowance must be made for the number of shots to be fired and also for the distance a person must travel before he can get in a safe shelter.

ELECTRIC BLASTING: When blasting is being done electrically, all persons

can be checked out of the blasting area before the shots are fired. The blasting switch or the blasting machine can always be located in a sheltered place and, of course, there is always sufficient time for a person to get out of range before the shots are fired.

VI.. *Injured by Concussion*

▶ Possible Cause:

1 Guard not warned as to the amount of explosive being used in the shot.

2 No allowance made for the lack of openings near the blast.

3 Standing near an opening that is perfectly safe from flying rocks, yet is so confined that the effect of the concussion can be felt.

4 Using excessive amount of explosive.

5 Concussion dislodging and throwing material against a person.

▶ Suggested Preventative:

FUSE BLASTING: In posting guards, these should be placed in a safe location and should be instructed as to the nature of the blasting being done. If they are inexperienced, they should be warned not to approach any nearer to the shot than that point at which they have been stationed.

The amount of concussion a person suffers from a shot depends to a great extent on the nature of the surroundings. Where there are many openings leading from the vicinity of the shot, a person may stand comparatively close with no bad effects; however, where there is but one opening, a person may suffer from the concussion even when standing some distance away.

Explosives should be issued on written orders. Unless the miner is limited to the correct amount of explosive to break his round, he has a tendency to overcharge. This practice is not only wasteful but is one of the greatest causes of excessive concussion.

When posting a guard, do not put him in a position where he can be struck with swinging doors, loose rocks, or falling material, any of which might be dislodged by the concussion produced by the blast.

ELECTRIC BLASTING: With electric blasting, the actual firing may be done from an independent level or section of the mine, remote from that section in which the blasting is taking place. This is especially important when firing large rounds such as are used when shooting out pillars or shooting down stopes.

(To be continued)

Automatic Crusher Plant

Increases Tonnage

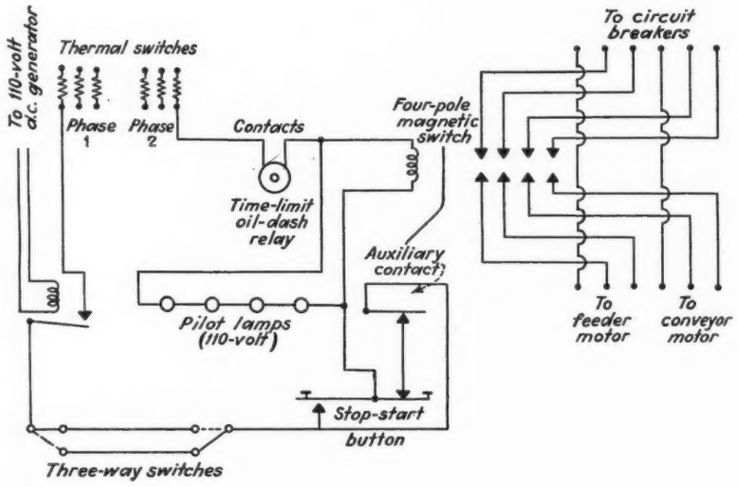
A NEW SYSTEM of synchronizing automatically the ore feed to the maximum capacity of the primary crusher is in operation at the California Standard Gold Mines near Jamestown, Calif., according to Allan F. Lake, plant electrician. Mr. Lake says that the system has increased tonnage approximately 25 per cent. The ore feed cannot be maintained manually, as the ore characteristics vary and prevent consistent manual feeding.

The plant layout is as follows: The feeder is located under the primary ore bin, delivering to a conveyor belt which dumps over a magnetic pulley to a Blake-type jaw crusher. The crusher delivers to a conveyor belt, thence to an elevator, over a vibrating screen to a Symons cone crusher, and thence via another elevator to the secondary ore bin. Conveyors and elevators were necessitated because of a flat mill site. The equipment is so interlocked electrically that in event of elevator jams or magnetic pulley failure the ore feed is instantly stopped.

Essentially the automatic character of the ore feed is obtained by disconnecting the contacts of one time-limit oil dash-pot relay of the primary crusher motor, connecting these contacts to feed the coil of a four-pole magnetic switch. This switch energizes the motors of the feeder and primary conveyor belt simultaneously. A "start" and "stop" button is provided for manual control from the cone crusher location and two three-way switches are provided for manual control from either the jaw crusher or feeder locations. Interlocking of the elevators is accomplished by taking one phase from the "load" side of the thermal feeder switch and one from the conveyor switch. A "jam" in either elevator trips out its respective thermal, thus cutting off the energizing current for the four-pole magnetic switch.

Use of one time-limit dash relay on the jaw crusher motor does not in this case detract from motor protection, as the motor is fed from a "De-Ion" circuit breaker panel board, in which all three phases are opened on either overload or short circuit. Pilot lights are installed in parallel with the four pole switch and coil, which warn the operator of the automatic starting of the feeder and belt.

Regulation of the dash-pot relay to disconnect the feeder when the crusher flywheel inertia is below normal may be accomplished by: (1) Changing the viscosity of the oil in the dash pot. (2) Changing the valve opening in the piston. (3) Changing the stroke of the solenoid plunger. (4) Removing the dash pot entirely and adding weights thereto. The method used varies according to the relation of crusher to motor capacity.



Shaft Sinking

In Wet Gravel

The Author Also Describes the Moving of an 80-Foot Headframe 2,000 Feet to the New Site

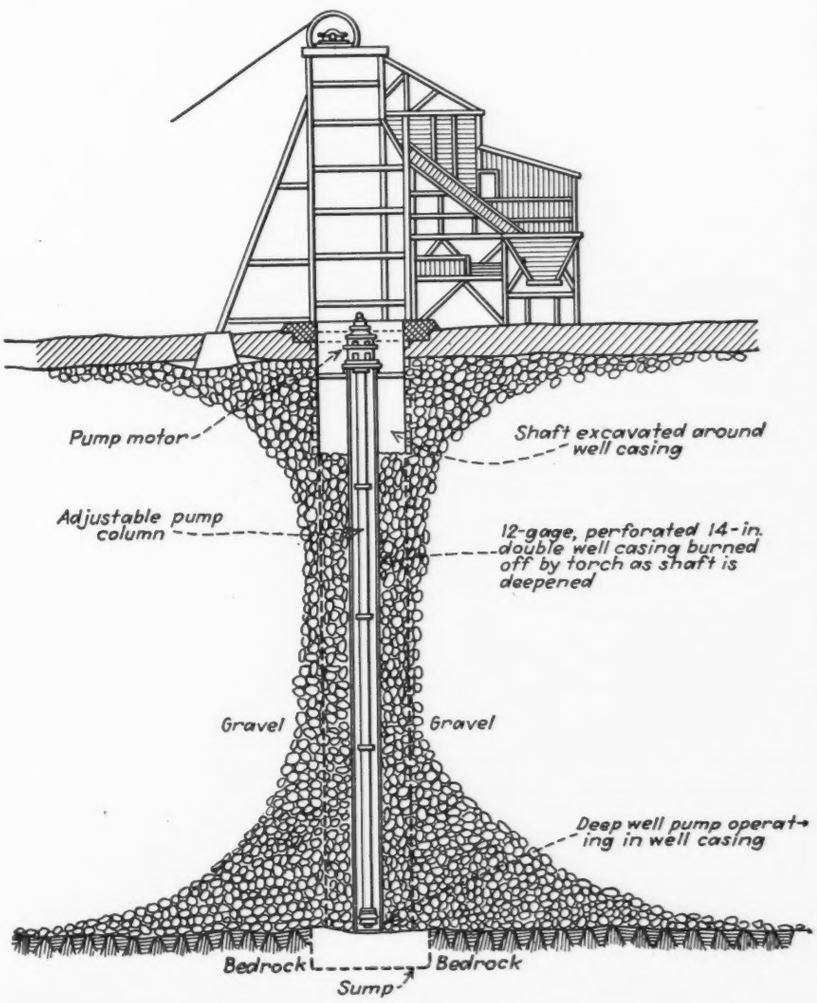
E. R. Gray

Manager, Gray Wing Extension Mining Company
Folson, Calif.

FOUR miles east of Folsom, Calif., the Blue Ravine channel is under exploitation by the Gray Wing Extension Mining Company. It consists entirely of gravel covered with a layer of top soil only about 1 ft. thick. The gravel is loose and wet and extends to a depth exceeding 70 ft. Shaft-sinking operations in this ground obviously must be carried on with great care if speed and safety are to be assured; hence a description of the methods applied by the company to attain these objectives may be of interest to others similarly engaged.

In 1932, the company sank the first shaft a distance of 83 ft. to bedrock. Anticipating a flow of water of from 500 to 600 g.p.m., it was decided to make the shaft 5x10½ ft. in the clear, with a hoisting compartment measuring 5x4 ft. and a pump compartment 5x6½ ft. in cross-section. Water was encountered at 20 ft. At 48 ft. a watercourse making 600 g.p.m. was struck in small, very loose gravel. To handle this volume of water, a Krogh centrifugal sinking pump was installed, but it was found that whirlpools permitted a small amount of air to enter the pump chamber, with a consequent 50 per cent loss of pumping capacity. In addition, the gravel was so loose that it was impossible to prevent it from running into the shaft excavation. To overcome these obstacles, a drill was installed over the shaft and a 14-in. hole sunk to bedrock, using a perforated single casing, for the express purpose of housing a 20-ft. pump suction and simultaneously unloading water from the loose gravel. The results attained passed expectations, but an ever-increasing flow of water made necessary the installation of a larger pump. As a consequence a stationary Byron Jackson centrifugal pump, capable of handling 800 g.p.m. and with a flexible suction column extending 22 ft. down the drill hole, was installed.

Next, sinking operations were resumed around the drill hole, the casing being burned off at intervals in accordance to the depth of the shaft reached. Pumping operations proceeded in a satisfactory manner until the pump had to be lowered. This change was found to require at least one hour, which was out of the question in view of the heavy flow of water. The problem was satisfactorily solved by the installation of a specially built 7-in. Byron Jackson deep-well turbine pump fitted with an adjustable pump column. Each necessary change was made in about 30 min., as compared to ten hours when the entire pump installation had to be taken apart. After completion of the shaft it was found that the loose watercourse gravel had run in from behind the shaft sets at a point 60 ft. from the collar of the shaft, which necessitated opening the lagging and filling in the hole with about 75 tons of waste material. The installation of the deep-well pump operating in the drill hole is graphi-



SHAFT SINKING through wet gravel was carried out by drilling a 14-in. hole to bedrock as shown, using a perforated well casing. A deep-well pump was lowered through this casing and sinking began. As the shaft deepened the casing was burned off in successive sections by a torch

THIS HEADFRAME, 80 ft. high, was detached from its foundations, placed on rollers, and moved 2,000 ft. to its new site. Compressor and hoist house, in the rear, were similarly moved

WITH THE HEADFRAME in its new location, the author and the contractors "take five" to have their picture taken

cally described in the accompanying line cut.

After completion of the shaft, active mining of gravel commenced. Prospect holes indicated a depth of about 72 ft. to bedrock, and when a crosscut was driven southeast from the shaft at a depth of 83 ft., it was found that the channel had dropped to that depth, and continuing downstream no bottom could be found. In this crosscut also were encountered a large number of boulders weighing a ton and less. Overhead there was very loose gravel. In places the boulders were so numerous that only a part of them could be stored underground; the remainder had to be reduced by blasting to a size to permit hoisting to the surface.

In breasting out this ground, the work revealed that the bedrock had risen about 10 ft., and it was below this fall that the boulders rested. Luckily, considerable gold was encountered around these boulders; in fact, one ten-day run averaged $31.80 per hoisted ton of material at $20.67 gold. Exploitation of this gravel meant the sinking of a new shaft and the erection of a surface plant.

The new two-compartment shaft was sunk to a depth of 84 ft. by the method described previously. A 14-in. hole, using 12-gage, perforated double well casing, was first drilled to bedrock. This was followed by the installation of the deep-well turbine pump, which delivered about 500 g.p.m. Shaft-sinking operations were then started around the well casing, and because of the compactness and small dimensions of the pump, a shaft measuring 5x7½ ft. was found to be adequate. (I have found that by making a shaft 5 ft. instead of 4 ft. in the clear, the 6 in. extra clearance on each side of the skip makes for safer riding on the skip.)

The hoisting compartment is 5x4 ft., and the combined pump and manway is 5x3½ ft. in cross-section. As sinking of the shaft progressed, the perforated casing was ripped off at intervals, and this manner of pumping unloaded the water from the loose streaks and enabled the crew to sink 6 ft. below the timbers, and in timbering to butt the lagging halfway behind each set. The shaft has not a single wedge or bridge in its entire length.

As to a surface plant, the millwright calculated that it would be less expensive to build a new plant than to dismantle the old one and re-erect it at the new shaft. In view of the flat country, I conceived the idea of moving the entire surface plant to the new site by conventional house-moving methods. Accordingly, several contractors were consulted and an agreement was entered into.

The plant, consisting of an 80-ft. headframe with a 1½-ton skip and built-in washing plant, hoist house, dry room, blacksmith shop, timber shed, an office building, and a 20,000-gal. redwood tank, was moved and placed in the exact position at the new site as it was before, about 2,000 ft. west of the old shaft. As the underpinning and moving of the machinery was to be done by company men, it was decided to wait until the headframe had been loaded on rollers and moved off the old base, after which the 12 in. by 12 in. by 20-ft. base timbers and the 10x12-in. stringers were taken up, leveled, and set in place at the new shaft. When the movers landed the headframe they set it over this underpinning and lowered it so that the tenons on the twelve legs dropped into the mortises in the stringers, and the six side and end braces rested on the concrete foundations prepared for them.

The machinery and hoist room contains a switchboard, hoist, a compressor, and auxiliaries. This equipment had to be lifted off the concrete foundations and moved out of the building before transportation to the new site, but the contractors suggested that a cut be made through the floors and floor joists, and two spaces be taken out at the end of the building in order that they could pull away the building with the switchboard and all wiring intact and spot it in the exact position at the new shaft. Company workers then dug the pits, poured the concrete bases through the holes in the floor of the building, and brought the machinery from the old shaft and erected it on the new foundations.

▼ ▼ ▼

Efficient Rail Cutter

CUTTING RAILS to size for underground tracks is a task performed almost daily at the mine blacksmith shop. Usually this is done in a power saw when such a machine is available or with a chisel and sledge hammer, as at the smaller shops. Both methods are time-consuming and costly.

At the mines of Anaconda Copper Mining Company, Butte, Mont., this problem has been successfully solved by the special rail cutter developed by J. H. Simmons, shop foreman, and

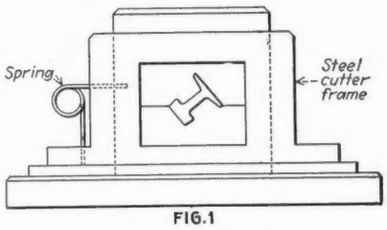


FIG. 1

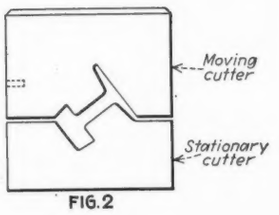


FIG. 2

shown in the accompanying line cut. In design it is akin to a power shear, consisting of a sturdy steel frame and two tempered knives or cutters. The movable cutter is held in position by a strong spring. Operation is relatively simple.

After the device has been properly secured to the anvil of a steam or air hammer, the marked rail is inserted between the two cutters shown in detail in Fig. 2, then adjusted at the desired point, and severed by a single blow of the hammer. The rail ends are practically as smooth as those obtained by the power-saw method.

Some Trends in Milling Gold And Silver Ores

A Comparison of Present and Past Practice

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▶DETAILED STUDY *of a large number of flowsheets of current ore-dressing and treatment practices in North America and the Philippines served to show how the metallurgy of gold has reverted to practices in vogue (say up to 1910) before millmen became so imbued with the idea of fine-grinding everything and cyaniding. This stimulated the preparation for the following paragraphs, in which the writer has drawn freely upon his own experience and observations. If by chance some metallurgists disagree with anything that is said, their comment will be welcome. Various phases of ore dressing and related topics are dealt with briefly and in such sequence as has seemed convenient.*

SORTING may mean the difference between profit and loss, or between operating and being shut down. It should be done where possible. Many ores do not lend themselves to sorting, because the mineralization is too disseminated—Homestake, Tonopah, Porcupine, and Kalgoorlie, for example. Other ores do and in enormous tonnages, as for example those of Alaska Juneau, Cripple Creek, Howey, Kolar, Morro Velho, the Rand, and the Yellow Aster mines. The percentage of worthless rock ranges from 5 to 50. The sorting is generally well done and the discard, which should be sampled and panned or assayed regularly, is often of lower value than the mill residue.

In testing an ore for treatment, the first thing to do is to examine it microscopically and then determine whether sorting is adaptable. We find an increasing number of mines, large and small, doing more or less sorting. It is not expensive; it reduces the tonnage to be milled, raises the ore grade, and rids the plant of material that may be a nuisance and carry away gold in the residue. Sorting may be done partly underground and partly on the surface or all on the surface.

Although many individual ores and ores from large centers cannot be sorted, because of the dissemination of minerals, yet, when such ores have been crushed and ground, and the minerals recovered by flotation, for example, only the concentrates (say a tenth of the total tonnage) require treatment, and the remainder may be wasted. We see conspicuous examples of this at the Beattie, McIntyre-Porcupine, Lake View & Star, and Wiluna. It is a practice that at one time would have been held impossible, and it may grow as metallurgists become less timid about discarding a dollar or two a ton.

Crushing With Rolls—Rolls have always been favored by lead and zinc millmen, and were often used in gold and silver plants, but became almost bypassed in the latter. Now they are returning to the flowsheet, giving much satisfaction. Good examples of their operation are to be seen in the Porcupine district, Ontario, where we spent some time watching a pair in the McIntyre-Porcupine plant. Rolls may be fed from the crusher-bin by means of a belt, thus giving them regular feed. Their product is more even than that of other machines and is suitable for the feeding of tube mills which are operated as primary grinders. In fact, none of the existing crushers are entirely satisfactory below ½-in. size, so the roll fits in nicely for the finer feed demanded, as low as 12 mesh in some plants. Therefore, rolls are to be recommended for applications discussed in the foregoing.

Crushing by Stamps—Whether to use stamps or ball mills or rod mills is more or less a question of economics—first cost, suitability, and running cost. Nowadays, few new stamp mills are erected at new mines or at reopened mines. At other mines, stamps may have been acquired locally from another property or cheaply from machinery dealers. Half of the world's gold-silver ore is still crushed by stamps, the Rand accounting for most of this amount, its total being 40,000,000 tons a year. In North America, the Homestake is a notable example of the continuous use of stamps, a new lot being installed during 1935, and there are many stamps dropping in various parts of the world. However, the trend everywhere is to the ball mill or rod mill, which is a simple machine when compared to the stamp. We are interested to learn that stamps—50 of them—are retained at the Yellow Aster mine, in California. When the plant had been extensively repaired in the latter part of 1933, according to C. L. Cooper in *Information Circular 6900* of the United States Bureau of Mines, August, 1936, it included fifty 1,080-lb. stamps and employed amalgamation inside the mortar boxes and on copper plates. Tailings are cyanided. What factors influenced the retention of stamps at Yellow Aster is not stated, but doubtless the fact that they were there and could be overhauled was a deciding point. The 50 head crush 185 tons a day of a soft to hard granitic ore.

Excessive Grinding—Twenty years ago, 100 to 150 mesh was considered to be fine grinding, and the need for and cost of further comminution were seriously considered. Gradually, as mill design and practice improved, and as the necessity of freeing gold from the gangue and minerals adhering to it or incasing it became better understood, grinding to 200 mesh was the vogue. Of late, all through 270, 300, and 400 mesh is the practice in some mills. These are known as "sub-sieve" sizes. Ordinary sieve-sizing or analysis is impossible and unsuitable for this fine stuff, so resort is had to elutriators to know how fine is the grinding. Such fineness may be essential, but what is the cost? Does the value of the in-

crease in recovery much exceed the higher cost?

Impoverishment of Pulp—In his chapter "Ore Concentration," in *Minerals Yearbook, 1935,* United States Bureau of Mines, T. H. Miller remarks as follows:

"The recent trend toward adoption of special equipment to recover gold in the primary grinding circuit was continued in 1934. A considerable number of gold and silver mills, both large and small, now employ traps, riffles, blankets, unit flotation cells, tables, and other equipment in the ball mill-classifier circuit to recover gold at as early a stage as possible. The use of corduroy or canvas tables is gaining favor. At a few plants that formerly used plate amalgamation the plates have been discontinued for these other methods of recovering rich gold concentrates which are, in certain instances, treated in pan or barrel amalgamators to recover bullion. This new trend eventually may lead to a large decrease in the quantity of gold ore treated by direct amalgamation. Cyanidation continues to play an important part in gold-mill circuits either by direct application to the crude ore or flotation tailings or by treatment of gold concentrates.

"Recovery of gold in the grinding circuit, together with better flotation results, has resulted in lower-grade tailings; however, in many cases, due to the increased price of gold, the tailings still are too valuable to discard and cyanidation of final mill tailings to reduce tailings losses further is rapidly expanding. [The Idaho-Maryland at Grass Valley, California, for example, recently built a leaching plant to cyanide tailings from its cyanide and flotation mill.]

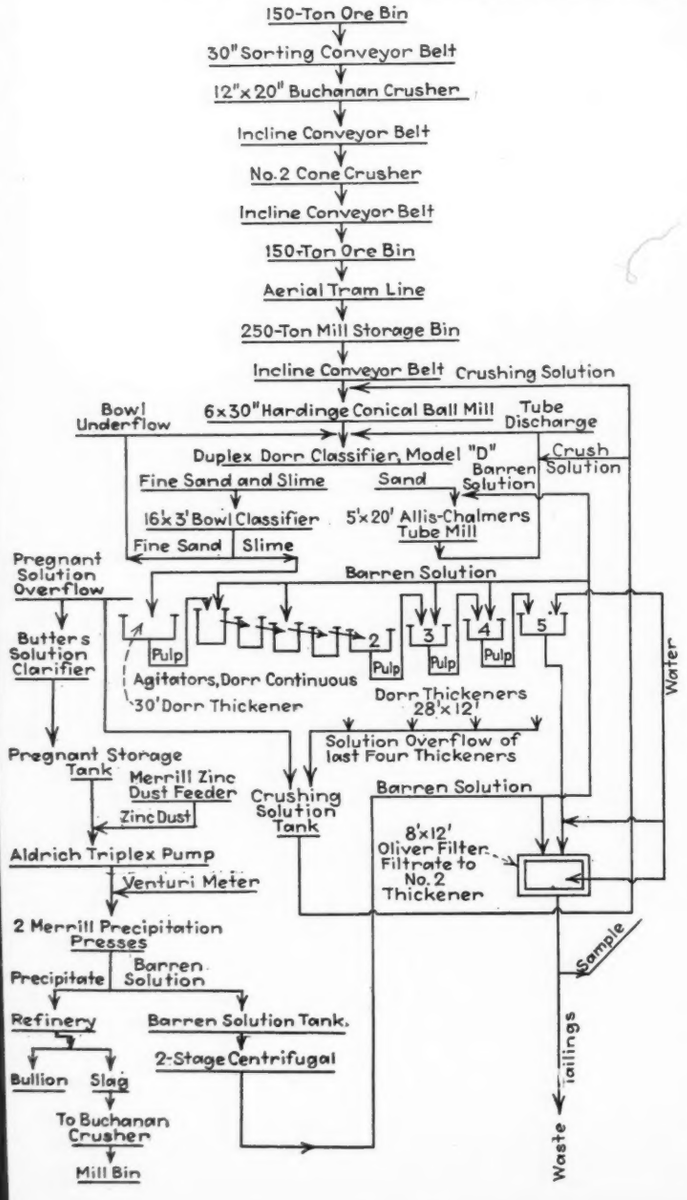
"There was an increase in both the number of gold and silver mills using flotation and the quantity of material treated. Most of the plants were combination mills using flotation in conjunction with other methods. As in the past, flotation-reagent combinations used in gold circuits continue to represent a large variety of types, and several new combinations were reported."

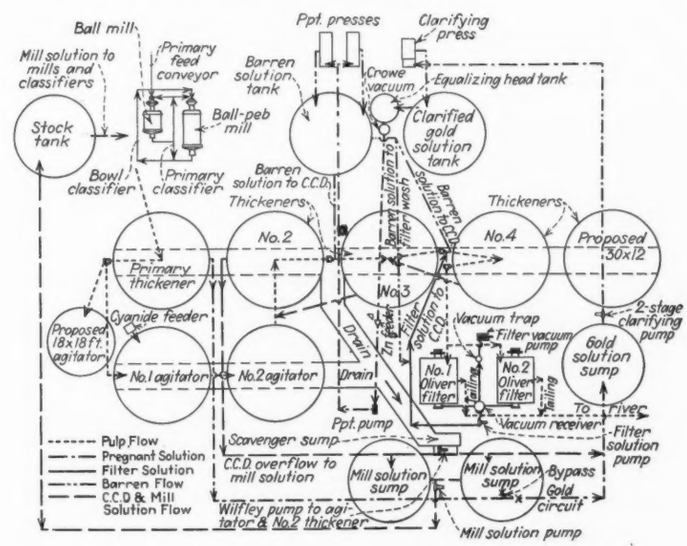
Of two metallurgists who were consulted regarding this general problem, the first considers this procedure to be quite natural and proper, especially in connection with the trend toward flotation of gold ore.

The second engineer, a man of world-wide experience, is strongly for impoverishment of the pulp before cyaniding is begun, as exemplified by the Homestake and the Rand; but, he adds, flotation, with cyaniding of the concentrate, is applicable in many instances, yet it is not suitable for all ores. (Flotation was given a lengthy trial at the Yellow Aster, but gave way to amalgamation, which had already saved the gold from 3,000,000 tons of ore.)

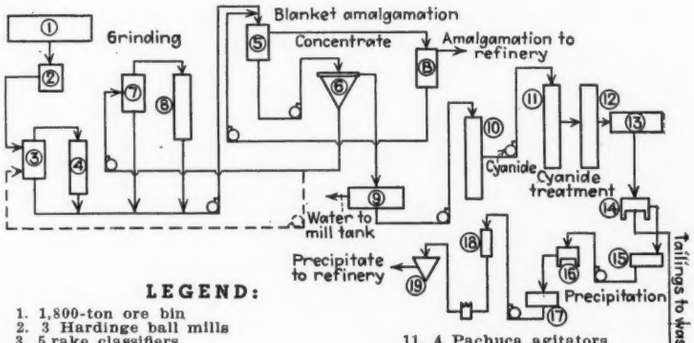
Too often the fact is overlooked that cyanidation gives a "recovery" of gold, whereas concentration merely gives an "extraction" of concentrate. On some ores a concentrate may be

THE TOBURN MILL, at Kirkland Lake, Ont., uses countercurrent decantation, as shown in the flowsheet at the left. The upper flowsheet at the right is that used in treating the ore at Benguet Consolidated's Ipo mine, in the Philippines. Here, also, countercurrent decantation is employed. Gold bullion of a fineness of 850 to 900 is produced





DOME MINES' blanket plant, in the Porcupine district of northern Ontario, is well known. Cyanidation follows the treatment by amalgamation. The generalized flowsheet is shown immediately below



LEGEND:

1. 1,800-ton ore bin
2. 3 Hardinge ball mills
3. 5 rake classifiers
4. 5 tube mills
5. 28 corduroy tables
6. 2 distributor cones; 15 classifier cones
7. 4 rake classifiers
8. 2 tube mills
8. 3 amalgam barrels
9. 4 balanced tray thickeners
10. 4 Pachuca agitators
11. 4 Pachuca agitators
12. 4 Pachuca agitators
13. 1 surge tank
14. 5 filter presses
15. Unclarified solution
16. 2 clarifiers
17. Clarified solution
18. Crowe tank
19. 3 precipitation filters, dome

made and cyanided, but to get extractions comparable to straight cyanidation, one must cyanide the flotation tailing too, which may bring one about where he started.

Amalgamation—Few mines, excepting those in the prospect or development stage, have amalgamation plus corduroy as the sole means of gold recovery. An example is the mine of Mount Tsi, operated by the Kilo-Moto company in northeast Belgian Congo. According to R. Anthoine, of Brussels, treatment consists of grinding in Chilean mills, followed by amalgamation on copper plates, then by corduroy, dewatering, tube-milling and classification, and a second amalgamation on copper plates followed by corduroy. The monthly tonnage is around 24,000, and the percentage recovered is 89, at low cost. Here may be termed a reversion to Chilean mills and amalgamation, supplemented by corduroy, the product of which is amalgamated, the whole doing satisfactory work.

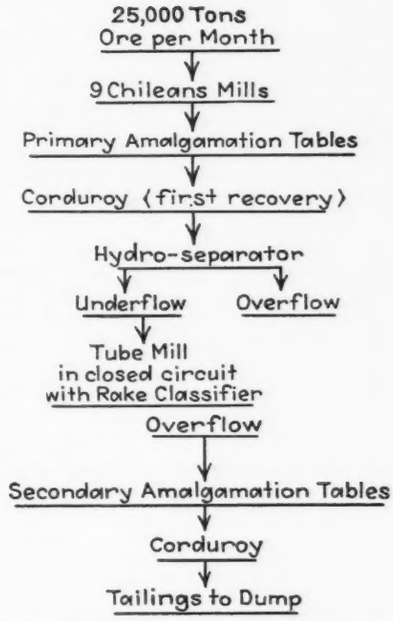
At the Yellow Aster mine, amalgamation is the only process used in the mill proper. Stamps do the crushing there.

Corduroy as a Gold-saver—In the saving of gold in the early stages of dressing and treatment of ore, apart from the use of copper plates, blankets or canvas was used many years ago. Then, for a period, they were more or less forgotten. In recent years the copper plate has been largely superseded by a simple and more satisfactory medium—corduroy.

Gold-saving by corduroy is not amalgamation, but it depends upon mercury for recovery of the free gold and heavy minerals caught thereby, this being amalgamation as part of the clean-up. This is done mostly in revolving barrels, a well-known practice. The old berdan pan has been revived to some extent for this purpose of cleaning and amalgamating the gold. We have used a berdan pan, as well as barrels, and for small plants would commend its good work. Its rich contents are open to easy theft when compared to the barrel.

Gravity Concentration — Flotation would not have made such headway if gravity tables and vanners had been able to save the fine particles of mineral; they excel with the coarse particles. But even now we find gravity tables in modern plants doing primary and secondary concentration, as in the Alaska Juneau; O'Brien, in Quebec; Parkhill, in Ontario; and Waihi, in New Zealand. In the Hollinger plant are a couple of hundred double-deck tables, but they are separating sulphides, which are ground fine and then mixed with the pulp stream.

Dewatering—Cones (Allen, Callow, Homestake, Caldecott) as dewaterers and classifiers, and formerly for sizing, are more or less used for dewatering concentrates or middlings or for separating fine slime where a quiet overflow is desired. Classification is not sizing, nor conversely. Cones are to be found doing satisfactory work in the Homestake, Dome, O'Brien, and Central Manitoba mills, as well as in those of the Kolar field and of the Rand. Here, they are used mainly as dewaterers and as such have somewhat hindered the introduction of rake and spiral classifiers of the Dorr, Akins, and Hardinge types.



AMALGAMATION and recovery on corduroy are features of the treatment given the ore from the Mont Tsi gold mine of the Kilo-Moto company, in the Belgian Congo. The principal steps in the flowsheet are given

Agitation — The greater speed of agitation of pulp is a relatively recent reversal of earlier practice. Agitators of the Dorr type are run several revolutions faster, and the Wallace and Devereux types remind us of the A Z machine which did good work at 60 revolutions per minute at Kalgoorlie for many years until recently. Faster agitation means several things—less time, less power, less consumption of cyanide, and quicker and greater dissolution of gold. Compressed air is also being admitted into the pulp by several devices—an old practice.

Decantation—In the *Mining and Scientific Press* for July 22, 1911, Donald F. Irvin wrote that within recent years there had been a noticeable tendency toward continuous methods in metallurgy. In the cyaniding of slime, which was, in most cases, accomplished by treatment of successive charges, was a big field for continuous processes. He then discussed continuous decantation—the C. C. D. process. At the present time we find some reversal to that system, with satisfactory results, at the Toburn, at Kirkland Lake, Ontario; the Golden Queen, in Kern County, Calif.; at the Cal Horr and Ipo plants, in the Philippines; and at Hannans North, at Kalgoorlie, Western Australia. Filters may follow the C. C. D. system, to save weak solution, some gold, or water.

Pulp Transfer—Air lifts were once extensively used for transferring coarse and fine materials and solutions. Then, plunger pumps and later centrifugal pumps took their place. Relatively recently, the air lift has again come into considerable use, more especially in such equipment as the Denver, Dorr, and Wallace agitators. Compressed air is also freed in agitators.

Pulp Temperature—The heating of mill pulp, in warm weather or in cold weather, was a feature of treatment at Tonopah, Nev. The silver-gold ore responded to temperatures of 100 deg., more or less. Other plants are doing this, a conspicuous example being Lake Shore, at Kirkland Lake, which holds the pulp temperature at around 83 deg. Only experimentation will tell whether it pays to heat cyanide solutions, which means greater dissolving power and no increase in cyanide consumption. Hot-roasted ore may be mixed with solution with little or no effect thereon, and with some quickening of dissolution of gold.

Roasting — Roasting of ores and concentrates has been popular in Australia, but only one plant now roasts all the gold-telluride ore — the South Kalgurli, at Kalgoorlie; but the roasting of concentrate is still done on a large scale at the Lake View & Star, Great Boulder, and Boulder Perseverance, at Kalgoorlie, and also at the Wiluna, at Wiluna. Australians believe in roasting concentrates, and rightly. In the United States the important example of roasting is the Golden Cycle plant, at Colorado Springs, treating a large tonnage of varied ores. The Goldfield Consolidated, at Goldfield, years ago roasted its concentrates. Cyanidation forms part of the subsequent treatment of the furnace product. Apart from the Golden Cycle, the Maitland (see page 125), and Little Long Lac plants, we know of few that are roasting, but such is planned, particularly in Canada. Roasting is not a difficult operation—air supply, rate of feed, temperatures at various points, and frequent testing of the roast by rapid method are the main features. Once concentrates are burning, they will calcine themselves. If roasting is well done, cyanidation will not present any difficulty.

In some plants, concentrates after being cyanided are returned to the mill pulp for further treatment. This costs money and reveals a weakness

somewhere along the line. A sweet roast, grind, passage over corduroy, and agitation with cyanide would correct such procedure.

Old and New Processes, or Either—E. S. Leaver and J. A. Woolf say this in *Report of Investigations 3226* of the United States Bureau of Mines, March, 1934:

"When part of the gold in a milling ore is not recovered by the process in use, it is advisable to learn the association of such gold as a means of intelligently improving the recovery process. There is a tendency to favor a new process without due consideration for retaining the older ones, at least in part.

"Cyanidation largely replaced amalgation, and flotation is rapidly encroaching in the field of cyanidation. Now amalgamation [and corduroy] has demonstrated its place as a primary process for the recovery of coarse gold before either cyanidation or flotation. The method is suitable for recovery of coarse gold, thus decreasing the period of treatment under cyanidation or preventing loss of coarse gold in flotation tails. Gold in base-metal ores and ores that form cyanicides favor flotation prior to cyanidation.

"Gold does not float as readily or as rapidly as most of the mineral sulphides; therefore, if the percentage of gold in the flotation feed is high, a longer period of flotation is required. With the usual milling-grade ore, the time-factor is not so important.

"Almost complete recovery of clean metallic gold can be made by flotation, provided that the ore is all ground to pass 60 mesh and no interfering slime is present in the flotation feed.

"Gold coarser than 40 mesh is not recovered in the usual flotation concentrate."

These findings, which are part of a number, suggest some questions, such as: Did cyanidation largely replace amalgamation, except for gold which was too fine for saving by mercury or by woven materials? Why is the flotation of gold free of contaminating or inclosing substances continued when it can be simply and cheaply caught otherwise, and why grind unfloatable 40-mesh gold to 60 mesh and then float it? An engineer-professor friend answers this as follows:

Though considerable gold may be recovered in the earlier stages, it is apparently necessary to grind fine to free the gold and sulphides to get satisfactory flotation thereof. In other words, it may be possible to save coarse gold by amalgamation, traps, unit-flotation cells, and so forth, but the residue still contains too much gold to be thrown away and, therefore, it has to be ground finer and subsequently floated to make the final economic recovery.

Examination of tailings from different parts of the world revealed that in most of them much gold is lost because it is included in the gangue as small metallic grains, and more gold in such form is lost because, although freed in milling, the grains are coated with impurities. These coatings govern the processes best suited to extract the gold and what improvements should be made in treatment. If they are not removed early in the milling process, metallics will cause high and erratic residues.

In ore treatment, including iron ore, comminution is primarily for the purpose of freeing pay minerals from their gangue or worthless inclosing minerals, which may later be washed out or concentrated out. Some nonmetallic ores come under this class. Seldom is the reduction of two ores similar, the finished products suitable for one treatment may be unsuitable for another process. This reduction from rock to slime for treatment differs from the crushing and grinding of rock for, say, concrete or for cement-making or paint-fillers for which a certain piece or particle size is desired. Over-grinding comes into the picture in the endeavor to release minerals, and this costs money.

Different minerals require more or less grinding to produce the same degree of fineness, this being their grindability. In most metallurgical work there is an optimum or best size at which maximum extraction follows.

R. E. Head, one of our keenest workers on the physical characteristics of gold, especially that lost in tailings, says in *Technical Publication 674* of the A.I.M.E., 1936:

"It is quite likely that the characteristics of contaminated gold particles in the refractory ores differ sufficiently to preclude the possibility of developing a process other than smelting that will have universal application and yield consistently satisfactory results on all refractory gold ores. The situation, therefore, resolves itself into a matter of determining what process or combination of processes is best suited to extract the greatest amount of gold from a given ore at the lowest cost.

"After summarizing the considering the problem of recovering contaminated gold, several possible methods of attack present themselves:

"1. The possibility of finding some procedure for removing the surface contamination, thus conditioning the gold for treatment by cyanidation, amalgamation, or flotation.

"2. Utilizing the surface coating as a base for producing a more easily floatable surface through the agency of a suitable reagent or combination of reagents.

"3. The development of reagents that will selectively float the substances that form the coatings on refractory gold particles.

"4. The employment of refined gravity methods specifically designed and placed in mill circuits to aid gold recovery.

"5. The perfection of tailing launder design and operation as scavenging devices."

Concentration and Process Trends—In the United States flotation of gold and silver ores, although of a pioneering nature, was of minor importance until about 1930. In *Mineral Resources of the United States,* 1928, J. P. Dunlop remarks on page 898:

"No figures are available showing the quantity of gold and silver treated by flotation in 1928, but the increase, if any, was small and negligible compared with the immense tonnage of base ores so treated."

Dunlop says the same thing in his report on gold and silver for 1929.

Commencing with *Mineral Resources of the United States,* 1930, also in that volume for 1931, and in its successor, *Minerals Yearbook,* for 1932-33, 1934, and 1935, we find the figures given in Table I regarding flotation of gold and silver ores, which are presented by T. H. Miller and R. L. Kidd.

Table I—Gold and/or Silver Ore Treatment in United States

Year	Total Ore Mined, Tons	Total Ore Milled, Tons	Concentrating Plants, Reporting(*a*)	Total Ore Concentrated, Tons
1930	3,844,000	3,272,000	26	219,000
1931	4,134,000	3,429,000	33	609,000
1932	4,157,000	3,932,000	46	801,000
1933	4,509,000	4,270,000	70	1,264,000
1934	7,463,000	6,887,000	144	2,475,000
1935	Unavailable, but should be an increase.			

(*a*) These include straight flotation plants, combined flotation and gravity-concentration plants, and amalgamation or cyanidation plants in which flotation equipment was operated and from which fairly complete figures were obtained.

Table II—Tonnage of Ore Treated in United States by Concentration and by Combined Methods

Year	Straight Concentration	Concentration With Amalgamation or Cyanidation
1930	153,000	66,000
1931	226,000	802,000
1932	302,000	499,000
1933	567,000	697,000
1934	1,227,000	1,248,000
1935	Unavailable, but should be an increase	

Though straight concentration of gold and silver ores or of either has been gaining, so has combined concentration and amalgamation or cyanidation, as shown in Table II.

The general reports on gold and silver in *Mineral Resources of the United States* and in *Minerals Yearbook* of the United States Geological Survey and of the United States Bureau of Mines, by H. D. McCaskey, H. D. McCaskey and J. P. Dunlop, J. P. Dunlop, and C. W. Henderson and J. P. Dunlop, respectively, reveal the recovery of gold and silver from ores since 1910 as given in Table III, placers being omitted.

In Canada, according to figures supplied us by the Dominion Bureau of Statistics, at Ottawa, the output of gold by processes differs considerably from the data for the United States, as shown in Table IV.

The percentage in Column 3 is the bullion recovered by amalgamation and cyanidation. That saved by alluvial operations and by smelting copper and other ores is omitted.

References—For further study of current and earlier practice in the recovery of gold and silver from ores we commend the annual chapter of Robert H. Richards and Charles E. Locke—"Progress in Ore Dressing and Coal Preparation"—in *Mineral Industry*. They review the articles, papers, and books written from year to year, and thereby present a useful source of information.

The reports of the Metallurgical Division of the United States Bureau of Mines, published by the Government and in various technical organs, are a source of much original experimentation and careful presentation of findings.

In his "Mill and Cyanide Handbook" (Charles Griffin & Company, London, 1918) A. W. Allen shows a series of eight treatment charts of the period, all but the first being pertinent to this discussion. The others are as follows:

2. Crushing, amalgamating, leaching of sand, and separate treatment of slime. (Copper plates, classifying dewaterer, thickeners, and agitators are in the flowsheet.)

3. Coarse crushing, regrinding, amalgamation, leaching of sand, and separate treatment of slime. (In this case the regrinding precedes amalgamation, and the coarse sand from the classifier is returned to the classifying dewaterer, and thence to regrinding again.)

4. Crushing, amalgamation, concentration with separate cyanide treatment of concentrate, classification of tailing, and separate treatment of sand and slime. (In this circuit the concentrate is ground and the gold amalgamated in pans, and the slimed concentrate is agitated and eventually enters the agitators of the mill slime.)

5. Sliming in cyanide, separation of refractory product by concentration, and return to regrinding plant. (Here we have a tube mill in closed circuit with a classifying dewaterer and the eventual slime passes over concentrators, and the concentrate therefrom is reground and mixes with the final pulp, or, concentrators follow the mills and the concentrates are ground in a tube mill in closed circuit with the concentrators, eventually all concentrator tailing being mixed and cyanided.)

6. Sliming in water, separation of refractory concentrate for shipment. (This explains itself, regrinding in closed circuit forming part of the system.)

7. Sliming in solution, agitation with barren solution and continuous decantation during agitation.

8. Sliming in solution, followed by continuous decantation in Dorr tanks.

Solution charts, clean-up charts, and titration charts follow the treatment charts, and are suggestive to current practice.

Table III—Gold and Silver Recovered in the United States by Methods, Per Cent

	Amalgamation		Cyanidation		Smelting (Ores and Concentrates)	
	Gold	Silver	Gold	Silver	Gold	Silver
1911	23.9	1.54	26.1	14.3	22.0	84.0
1912	22.3	1.2	30.9	17.8	21.6	80.8
1913	21.5	0.6	31.2	19.7	22.1	79.5
1914	20.9	0.4	31.4	22.1	22.1	77.3
1915	22.8	0.4	30.4	22.1	23.6	77.3
1916	21.5	0.4	28.1	18.3	24.9	81.1
1917	20.9	0.4	29.5	16.3	23.6	83.1
1918	20.7	0.3	32.0	14.3	23.5	85.3
1919	31.5	0.5	28.5	13.8	14.4	85.5
1920	28.5	0.4	24.3	13.4	21.9	86.1
1921	32.6	0.45	23.9	16.0	14.6	83.4
1922	35.4	0.3	23.6	14.4	17.5	85.2
1923	28.4	0.3	25.3	14.3	23.4	85.3
1924	30.6	0.4	23.0	13.9	28.0	85.6
1925	32.6	0.3	20.7	9.5	27.8	90.1
1926	30.6	0.3	20.4	8.3	28.5	91.3
1927	30.8	0.3	17.9	7.0	29.9	92.6
1928	31.4	0.4	17.5	7.4	31.7	92.1
1929	30.1	0.4	15.8	5.3	34.3	94.2
1930	33.2	0.5	17.8	5.7	28.4	93.7
1931	36.2	0.9	17.8	4.2	25.6	94.7
1932	36.5	1.1	18.7	3.3	21.4	95.3
1933	38.8	1.6	15.3	1.0	20.7	97.1
1934	31.2	0.8	18.1	3.6	24.7	95.3

Table IV—Gold Production of Canada, by Processes

Year	Total, Fine Ounces	Fine Gold, in Bullion, Per Cent	Amalgamation Bullion, Ounces	Cyanidation Bullion, Ounces	Smelted Ores and Concentrates, Fine Ounces
1931	2,693,892	80.6	54,067	2,742,880	101,985
1932	3,044,387	79.3	238,954	2,985,285	84,498
1933	2,949,309	79.8	315,495	2,694,939	102,706
1934	2,972,074	78.7	359,785	2,806,633	158,691
1935	3,284,890	78.8	440,201	2,961,826	153,514

A Mine Cage Drop-Bar Holder

AN IMPORTANT FIXTURE on a hoisting cage besides the safety catches is the drop bar and its auxiliaries. The safety of the occupants of the cage depends particularly on the drop bar holder into which the drop bar proper is lowered after the cage has been loaded. To be efficient, it must be of simple design and positive in action, so as to release and lock securely the drop bar with a minimum of delay. One that meets these requirements is shown in Fig. 1. It was developed by the engineering research department of the Anaconda Copper Mining Company at Butte.

As explained, it consists of a steel forging with a simple lock mechanism in the lobular extension in the center, which is bolted to the side post of the cage. The lock mechanism is composed of a round-headed steel pin, a tension spring, a washer, and a split pin. To assure a smooth operating drop bar, the hinge of the bar is provided with a removable lid as shown in Fig. 2, which prevents dirt and grit from entering the hinge pin.

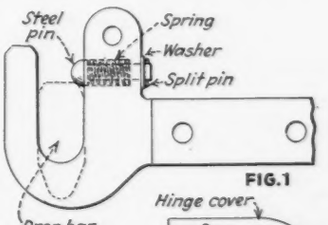


FIG.1

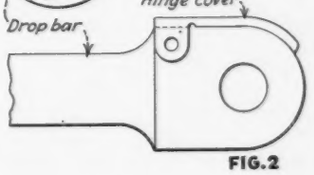
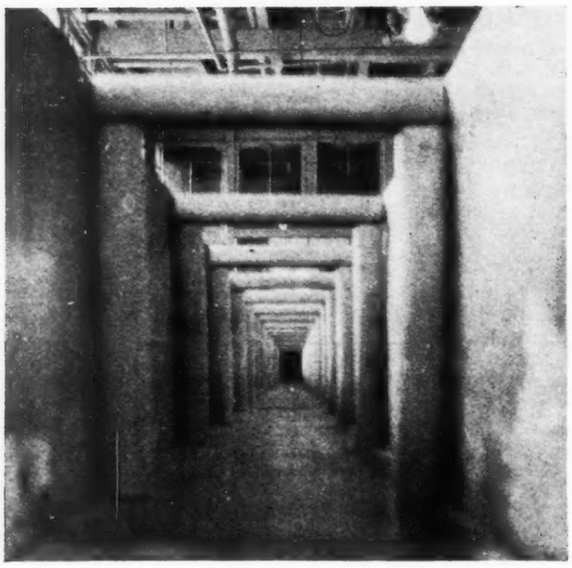


FIG.2



INSIDE THE DUCT. This shows round timber, in miniature, in place for testing. The sheet steel duct is 48½ ft. long and 7 in. wide by 8 in. high

Drift Model Aids in Studying Air Flow

Research Throws Some Light on the Effects Of Timbers and Their Spacing

J. R. Aho, K. Cropper, W. Hennoch, R. G. Pike, and R. S. Lewis [1]

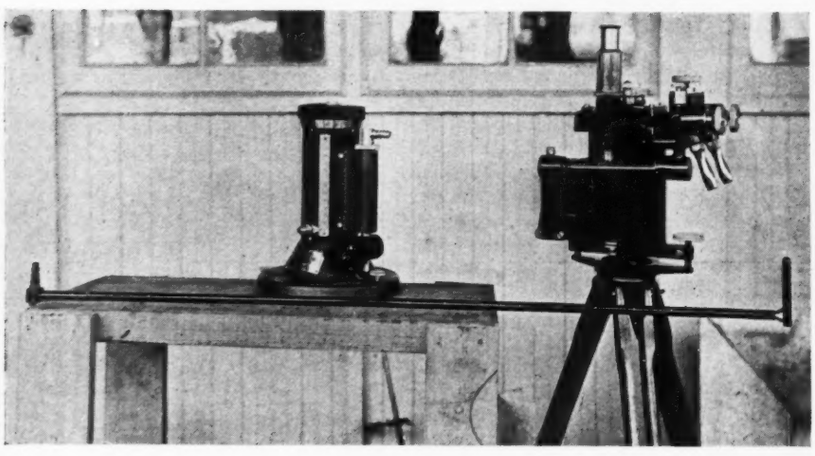
University of Utah, Salt Lake City, Utah

WHEN decision was made at the University of Utah to undertake research on the flow of air in mine workings under controlled conditions we lacked a mine drift in which square and round timbering could be placed as desired for our experiments. Moreover, had it been possible to secure such a drift the cost of placing the different shapes of timber at the various intervals as planned for the numerous tests would have been prohibitive in view of the limited funds available. For these reasons we decided to construct a duct of No. 10-gage sheet steel 7 in. wide and 8 in. high. The timbers were either 1 in. round or 1 in. square, corresponding to 12-in. timbers in a mine drift. Using three-piece sets, consisting of a cap and two posts, the net opening would be 5x7 in., which would correspond to 5x7 ft. in the clear in a full-size drift. Thus the scale of the work would be one-twelfth natural size. The total length of the duct was 48½ ft. An exhaust fan was used in the experiments. It was connected to the duct by a transformation piece, rectangular in shape at the end and fastened to the duct, and circular in form at the other end to correspond with the intake opening of the fan.

The timbers were made of clear pine to the exact size of 1 in. for both round and square timbers. Some difficulty was experienced at first in securing pieces of exact size, as mills thought a tolerance of $\frac{1}{16}$ to $\frac{3}{32}$ in. would be satisfactory, but after such timbers had been sent back and attention called to the specifications, little more trouble was experienced on this score. Small brads were used to fasten the pieces of a set together.

The lid of the duct was made air-tight, at first by the use of tar-paper gaskets covered with a thin coating of gilsonite paint. Later, thin sheet cork covered with a coating of hard cup grease gave a satisfactory air-tightness and proved easier and cleaner to handle. The duct was made in sections and 1½x1½-in. angle irons were used both for the sections and for the joints, which were bolted together. It was then carefully aligned with transit and level. For the first few tests the cover was bolted in place, but removing and replacing the bolts was tedious. By using 1-in. square steel bars laid along the edges of the cover, and by holding them down with carriage clamps, much time was saved in preparing for test runs.

APPARATUS used in the tests with the drift model. Left, the Askania manometer. Right, the Kent micromanometer. Also, the Prandtl pitot tube



Measuring Instruments—Both the average velocity of the flow of air and the drop in static pressure over a measured length of timbered duct were determined at each test. The velocity of flow was measured by an Ellison inclined gage having a range of 1 in. of water gage. For high velocities a gage with a range of 3 in. of water

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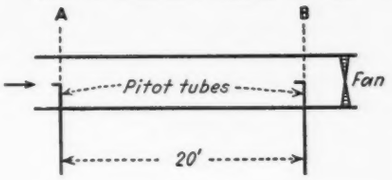
gage was used. These gages were filled with a red oil of 0.834 specific gravity at 60 deg. F. and were graduated to read directly in inches of water. Slight corrections were made for temperatures different from 60 deg. F.

For measuring the static drop over a test section, the Askania minimeter was chiefly used. This gage has a range of 5 in. of water gage and can be read with an accuracy of 4/10,000 of an inch of water gage. For very slight differences in pressure a Kent micromanometer was employed. This gage has an accuracy of 1/10,000 of an inch of water gage with the large displacer. A small displacer permits of reading down to 1/50,000 of an inch of water gage. This instrument is more sensitive to fluctuations in pressure than the minimeter.

To determine both the static drop and the velocity of flow, the Prandtl type of pitot tube was found to be most satisfactory. Two of these tubes were used on the test section and one was used to measure the velocity of the air. In this tube the static opening is a narrow circular slot instead of a series of small holes and the nose of the tube is semicircular. Tests in wind tunnels have shown that this tube retains its accuracy even though inclined to the direction of flow at a considerable angle. Up to inclinations of 15 deg. the error in reading is less than 1 per cent, and it is only about 2 per cent at an angle of inclination of 20 deg. These tubes were connected to their respective gages by heavy wall rubber tubing, which was tested from time to time to ascertain whether there was any leakage.

Fig. 1 . . . THE PRANDTL PITOT TUBES were arranged in this manner for the tests. They were placed symmetrically with respect to the timbering and at the point of maximum velocity of flow



For determining the weight of air per cubic foot at the time of each test, the United States Bureau of Mines type of sling psychrometer and a Fortin mercury barometer were used.

Method of Making Tests—The average velocity of flow was calculated from a traverse of nine points in the duct, representing nine equal areas. Three steel rods were screwed into a base plate 3 in. wide, ½ in. thick, and 9 in. long. This plate was clamped to the cover of the duct, and the pitot tube was supported from two clamps on each rod.

Three readings were taken at different vertical heights from each rod, so only three holes were made in the top of the duct. The two holes not in use were plugged flush with the inside of the cover. There was some fluctuation in the steadiness of flow of the air, so it seemed advisable to go to the extra work of making a traverse each time rather than to take a single center reading and compute a factor to reduce that reading to the average velocity of flow in the duct.

Preliminary investigations were made to determine the distance, both upstream from a timber set and also down stream from the set, that the flow of air was affected by the presence of the set. Since the position of the pitot tube could not well be changed, a set of timbers was moved from one position to another. After the flow of air was found to be unchanged by a move in position of the set, it was assumed

Fig. 2 . . . PRESSURE LOSSES in the experimental duct, as determined with both square and round timbers and without timbers, are plotted on these curves

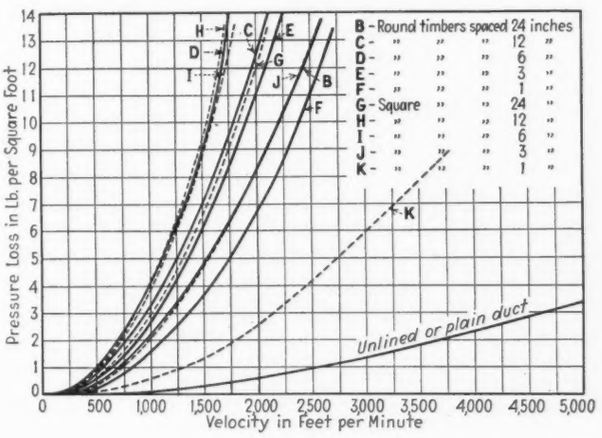
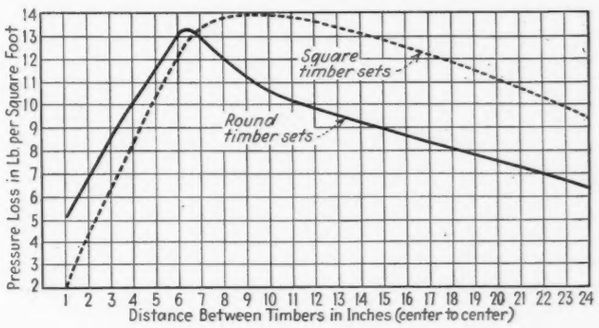
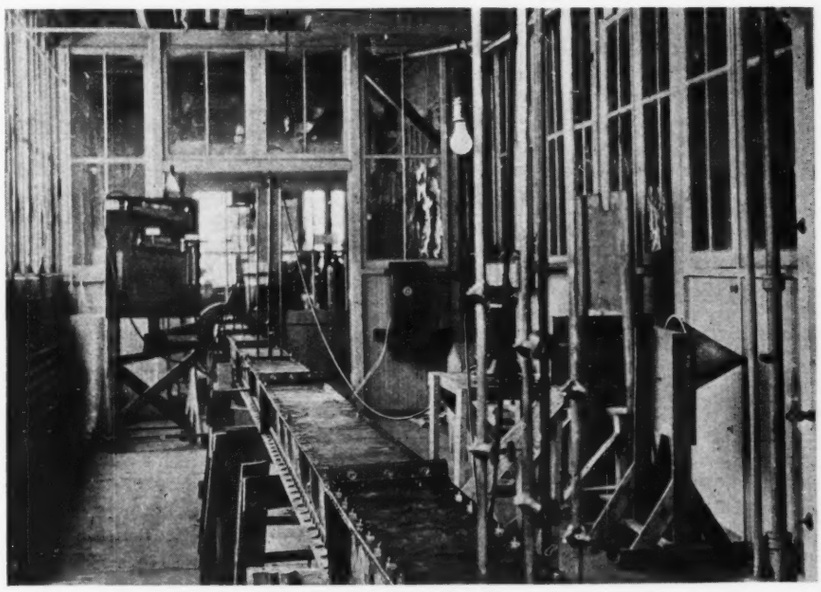

B - Round timbers spaced 24 inches
C - " " " 12 "
D - " " " 6 "
E - " " " 3 "
F - " " " 1 "
G - Square " " 24 "
H - " " " 12 "
I - " " " 6 "
J - " " " 3 "
K - " " " 1 "
Unlined or plain duct
Pressure Loss in Lb. per Square Foot
Velocity in Feet per Minute

Fig. 3 . . . PRESSURE LOSSES in the drift model obtained with round timbers and with square timbers, respectively, may be read from this graph


Square timber sets
Round timber sets
Pressure Loss in Lb. per Square Foot
Distance Between Timbers in Inches (center to center)

AN OUTSIDE VIEW of the experimental duct or drift model, with the gages used



that the effect of the set was no longer felt at the measuring station. These tests indicated that at a distance of about 12 in. upstream from a set and 12 ft. downstream from a set conditions of flow were not appreciably affected by the set. Thus the velocity measuring or traverse station was kept more than 12 ft. downstream from the last set in the test. This station was also about 8 ft. upstream from the transformation piece leading to the fan.

A length of 20 ft. was selected as the test section over which the drop in pressure of water gage was to be measured. The timbering was extended for 2 ft. beyond the measuring stations to insure that similar conditions of flow would obtain at each station; that is, 24 ft. of duct was timbered at each test. It would seem easier to have the pitot tube stations farther apart and in the smooth, untimbered parts of the duct, and then to determine the drop in pressure over the timbered sections by subtracting the calculated drop in pressure over the untimbered sections from the total measured drop in pressure, but since the preliminary tests indicated that the flow of air was affected by the presence of a set for some distance both above and below the set, it was felt desirable to measure the actual drop in pressure within the timbered section. (This point has been mentioned by Cooke & Statham, "Experiments on the Flow of Air in Ducts." *Trans.*, Institution of Mining Engineers, Vol. 73, p. 78, 1926-27.)

In the tests two Prandtl tubes were placed each the same distance downstream from the nearest upstream set of timbers; that is, the tubes were symmetrically placed in regard to the timbering, and also at the point of maximum velocity of flow in the duct for the two measuring stations. As a further check the velocities (maximum) at the two stations were measured to insure that the tubes were at points having the same velocities. This being established, the static drop between the two stations would give the drop in total pressure or resistance due to the timbering. See Fig. 1. This follows from the equations given below.

Let DTP = difference in total pressure, inches of water gage
MTP = mean total pressure
SP = static pressure
VP = velocity pressure

Then:

$$DTP = MTP \text{ at } B - MTP \text{ at } A$$
$$DTP = (SP \text{ at } B - VP \text{ at } B) - (SP \text{ at } A - VP \text{ at } A)$$
$$DTP = (SP \text{ at } B - SP \text{ at } A) - (VP \text{ at } B - VP \text{ at } A)$$

When the velocity pressures at A and B are equal, the last term in the foregoing equation becomes zero and the difference in total pressure is simply the difference in the static pressures at A and B.

Calculations — Barometric readings were corrected for differences in temperature by the formula:

$$B = B' (1.00288 - 0.00009\ t)$$

in which

B = corrected reading in inches of mercury
B' = observed reading in inches of mercury
t = thermometer (dry bulb) in degrees F.

To calculate the velocity of the air it was necessary to determine the weight of air per cubic foot, and this in turn required a determination of the vapor pressure of the moisture in the air. To determine the vapor pressure Beard's formula was used.

$$P_v = P_w - \frac{B}{30} \frac{(t_d - t_w)}{88}$$

in which

P_v = vapor pressure of moisture in the air in inches of mercury
P_w = saturated vapor pressure at wet bulb temperature
t_d = dry bulb temperature in degrees F.
t_w = wet bulb temperature in degrees F.

This is a simpler formula to solve than Ferrel's formula

$$P_v = P_w - 0.000367\ B\ (t_d - t_w)\ (1 + \frac{t_w - 32)}{1{,}571}$$

but gives the weight of air well within the limits of accuracy of the observations. The weight of air is then found from the formula:

$$W = \frac{1.3225}{459 + t}\ (B - 0.3777\ P_v)$$

in which

W = weight of air in pounds per cubic foot
t = dry bulb temperature in degrees F.
B = corrected barometric reading
P_v = calculated vapor pressure of moisture in the air

Next, the velocity of flow of the air is found from the expression

$$V = \frac{1097.4\ \sqrt{W.G.}}{\sqrt{W}}, \text{ in which}$$

V = velocity in feet per minute
$W.G.$ = water gage in inches
W = weight of air in pounds per cubic foot.

This formula shows that the velocity depends on the square root of the water gage. For the nine-point traverse for velocity the square root of each gage reading was found and the arithmetical average of these square roots was used in the formula. This could be done, since each of the nine readings represented an equal area in the duct.

Conclusions — The charts, Figs. 2 and 3, give the results of the tests, which were made with spacings that ranged from 24 in. down to 1 in. or with timbers placed skin to skin. In Fig. 3 the curve for square timbers shows that as the sets are brought closer and closer together, the resistance increases up to a spacing of 10 in., but from there on the resistance decreases as the timbers are placed closer together. Theoretically at 1-in. spacing, or with timbers skin to skin, the resistance would be that offered by a smooth and continuous timber surface.

The curve for round timbers has a sharper apex than that for square timbers. Round timbers offer less resistance than square timbers at spacings of 7 in. or above, but for close spacing round timbers offer more resistance to the flow of air than do square timbers.

Exact correlation between small-scale tests and actual mine airways would depend on the mine airways being geometrically similar in every way to the small duct, a condition that is not likely to be met, particularly in cases where timber sets are widely spaced, under which condition the resistance of the walls of the mine airway will be more in proportion than that of the smooth surface of the duct. Nevertheless, from a practical standpoint it might be suggested that where 12-in. timbers are to be used in a mine airway in which it is desirable to reduce the resistance to the flow of air to a minimum, it would be advantageous to use round timbers where the sets are to be 7 ft. or more apart and square sets where timbers are to be 6 ft. apart or still more closely spaced.

▼ ▼ ▼

When Cutting Roofing

In mill building and construction work it is often necessary to cut corrugated roofing lengthwise to fit windows, doors or large pipes, writes Charles Labbe, from Goldfield, Nev. With the common tinsnips it is too awkward, if possible, and too slow with cold chisel and hammer. The best means I have used is the back of a common carpenter saw acting as a shear. The end of the saw bears against a 2x4-in. piece of lumber nailed at the end of two timbers set close together, resting on a carpenter horse. The cut is just started to insert the saw, then with the saw as a "power" shear, the cutting is done fast, straight and with the least effort.

Mine Pumps

And

Their Selection

Suction and Discharge Lines . . III . . Providing Storage Capacity

Supplying Electric Power

Lamar Weaver

Assistant Mine Superintendent Tennessee Copper Company
Ducktown, Tenn.

INASMUCH as it is important to supply the pump with water at a minimum suction lift, free from air, the suction line should be carefully considered. The pipe should be as short and direct as possible, avoiding elbows and low places for air pockets. Suction pipe should always be as large as or larger than the suction opening on the pump. A suitable strainer should be used on the end of it. In some installations of automatic or hand-operated priming pumps it is necessary to use a good foot valve for priming. With vacuum or ejector priming methods, however, this valve may be omitted.

For the discharge, the pipe to be used depends on the nature of the water and the expected life of the pumping station that is to be served. Selection of the pipe may be considered under two heads: determining the most suitable material, and second, economical size.

Mine water usually carries suspended material and in some cases acid. Suspended material deposits in the pipe, building up an incrustation to the point where it is necessary to clean the line. Acid water often corrodes the pipe. For diameters larger than 6 in. where the head is low and the outside of the pipe can be kept free from acid water there is probably no better or more economical pipe than wood-stave pipe for handling acid water. For discharge lines that are under higher heads and that handle acid water, the most resistant material is probably cast iron, cement-lined; next, cast iron unlined; third, steel pipe lined with lead, wood, or cement; and, fourth, wrought-iron pipe.

For high pressures, wrought pipe of standard, extra strong, and double extra strong classification is available. See Table V. For a more durable discharge column the Mono-cast centrifugally made pipe is recommended up to certain heads. It gives good service for acid water. With a small additional investment for cement lining it has proved satisfactory in handling such water in both metal and coal mines. The cement lining is made very smooth so as to prevent loss by friction in the carrying capacity of the line. Table VI shows approximate prices for flanged pipe.

Where pressures and other conditions favor its use, wood-stave pipe has been proved to have advantages over metal pipe. Its interior remains clean and smooth throughout its entire life. Table VII gives prices and pressures for redwood and fir. For pipes larger in diameter than 12 in., the continuous stave form of pipe will not only be cheaper but also more satisfactory for conveying acid waters, in that it has individual bands that can be replaced as they deteriorate.

Size of Pipe—In a discharge line that is likely to be used for several years, it is well to use a pipe that is a size larger in diameter than the minimum required, to increase the length of the period of service between cleanings. As for the size of pipe, the selection should be based on the cost of power and the cost of pipe. It is not unusual to see a column pipe of a diameter double that of the pump discharge, inasmuch as the power rate justifies the purchase of the additional pipe size. The following example illustrates the usual method of proceeding in making the selection:

With a discharge of 1,000 g.p.m. of slightly acid water against a head of 800 ft. from a station having a possible 12-year life, and with the cost of electric power at $0.01 per kilowatt-hour, the pump running 10 hours per day, the unit pump efficiency 60 per cent, and money at 6 per cent interest, find the size of pipe warranted.

At 12 years the pump station will be changed and the pipe will have served its required life. One per cent of the pipe cost should be allowed for minor repairs and cleaning. Pipe friction is taken from a handbook. Table IX gives its value per 100 ft. for pipe ranging in diameter from 4 to 12 in. The value taken from this table must be multiplied by 8 for the 800-ft. lift. The friction power is computed for raising 1,000 g.p.m. of water for friction head only. From Table X this power is converted into money at the prevailing power rate. The interest rate is 6 per cent, the allowance for repairs 1 per cent, and the yearly amortization for 12 years' life is 8.3 per cent. Thus we have a total of 15.3 per cent of the original investment to be charged out each year for the use of the pipe. Because of the acid water and the life of the station a cement-lined cast-iron pipe is selected. Table VIII shows the purchaser the comparison of the investment for different sizes of pipe at a power cost of $0.01 per kilowatt-hour.

The 10-in. pipe is justified from these calculations. For other heads and volumes one finds it advisable to have a complete analysis of the pump and motor equipment, inasmuch as a further decrease in head might be warranted.

For handling larger volumes of water through a shaft it is the practice to use two pipes rather than one larger pipe of equivalent area. This will depend on the pump equipment and the available room in the shaft.

Storage of Mine Water—Mine water is stored usually in sumps, dams, or old workings. Sumps are usually located near the shaft to provide for shaft and level drainage. Development openings should be driven at a grade that will permit haulage economy. Usually this is about 0.5 per cent, a grade that is also ample for gravity drainage through ditches along the haulageway. Location near a shaft minimizes length of pipe and power lines and facilitates repairs and replacements. The storage sumps originally used can be supplemented later by using abandoned workings, with the aid of dams where conditions permit. Fig. 19 shows a station and sump at the Bunker Hill & Sullivan mine, in Idaho.

Some of the desirable features of a pump station are: Proximity to the

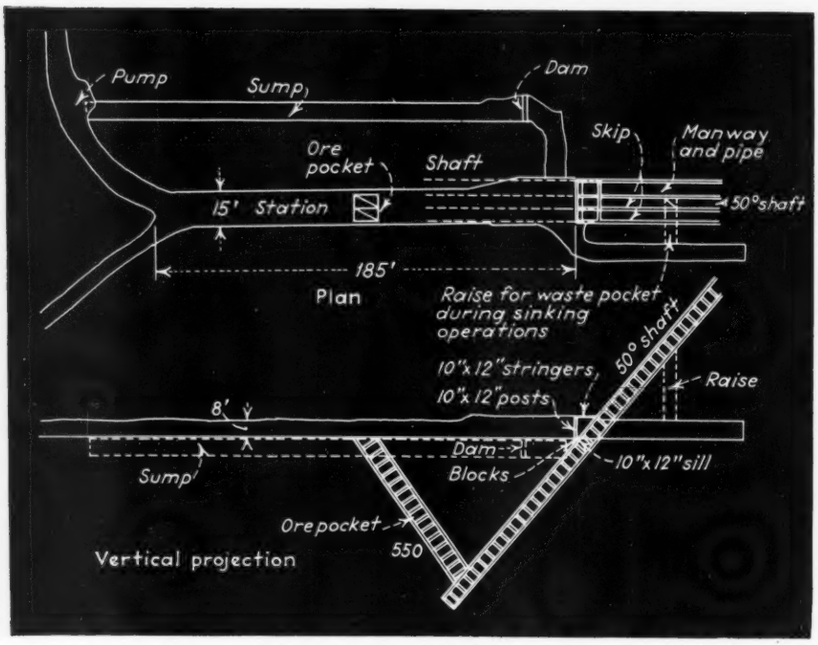


Fig. 19 . . . SUMP AND PUMP STATION in Bunker Hill and Sullivan mine, Coeur d'Alene district, northern Idaho

shaft; means for lifting heavy pump parts and conveying them to the shaft; ample space; and a layout that makes it possible to keep the place clean. The sump should be so constructed as to facilitate cleaning at intervals to remove sediment. This is effected by using both a settling sump and a storage sump, or by using two sumps connected by a tunnel with means for closing the connection. Thus the water can be diverted from one sump temporarily to the other while the sediment is being removed from the first.

The size of the sump depends on: (1) The inflow. The sump should be large enough to take care of the flow during the time required to make repairs. (2) The possibility of economy through providing storage capacity. The size must be sufficient to take care of the flow in order to protect the level. It may be secured by providing a spare unit giving additional storage. Provision of ample storage capacity has the following advantages:

(1) A lower initial cost of installation, because the capacity of the pump station may be determined by the average pumping rate instead of the maximum or peak quantity. (2) Use of a few pumps of larger capacity rather than smaller units adapted to suit varying pumping rates. (3) Possible elimination of an emergency pumping unit. (4) Possible lower operating cost, due to less need of attendance (pumping being done in fewer shifts), to a lower demand rate where power is purchased, and to a smaller power bill with purchased power secured by pumping during "off-peak" periods. (5) Insurance against flooding of the pump station in case of a temporary interruption of the power supply. (6) Lower maintenance cost due to better settling of grit and suspended matter.

In excavating for sumps of large capacity slushing equipment can be advantageously used for scraping the muck from the sump up to the level and over a slide into a mine car. If the level on which a sump is to be excavated has a suitable portable scraper loader that can be used for the mucking, a good unit cost can be assured. The cost of excavating a sump with a scraper should be about the same as other tight-breaking excavations, such as a drift round. Under average breaking conditions this would cost about 2c. per gallon of storage capacity.

A pump sump should be provided with a settling sump or catch basin for removing suspended solids. Also, means should be provided for efficiently removing these settlings. One ingenious method was the drilling of a 3½-in. diameter hole from the hoisting shaft up into the bottom of the sump. A suitable valve was sealed into each end of this hole for control purposes. The settlings are washed through this hole into the mine hoisting skips for hoisting to the surface for disposal through the waste dump as muddy water.

Another and probably a much more widely applicable means for disposal of the settlings is the use of a power-driven diaphragm pump for pumping the mud from the sump to the hoisting skips, as mentioned previously. Portable units of the regular construction contractor's pattern are standard equipment on the market. This portable pump can be moved in the mine cage to any level. The percentage of solids that this pump will lift is about 30. When pumping it is necessary to agitate with water or compressed air to clean the sump and keep the solution uniform.

Table V—Data for Standard Wrought-iron Pipe

Diameter Inches	Standard: Nominal Weight per Foot	Standard: Pressure Lb.	Standard: Price per Foot	Extra Strong: Nominal Weight per Foot	Extra Strong: Pressure Lb.	Extra Strong: Price per Foot	Double Extra Strong: Nominal Weight per Foot	Double Extra Strong: Pressure Lb.	Double Extra Strong: Price per Foot
4.....	10.89	658	$0.49	15.00	935	$0.75	27.54	1,871	$1.38
6.....	19.18	528	0.86	28.60	815	1.43	53.16	1,630	2.66
8.....	25.00	466	1.25	43.39	722	2.17	74.42	1,267	3.62
10.....	35.00	424	1.60	54.75	581	2.74	.....	.....	....
12.....	50.70	368	2.25	65.41	490	3.27	.....	.....	....

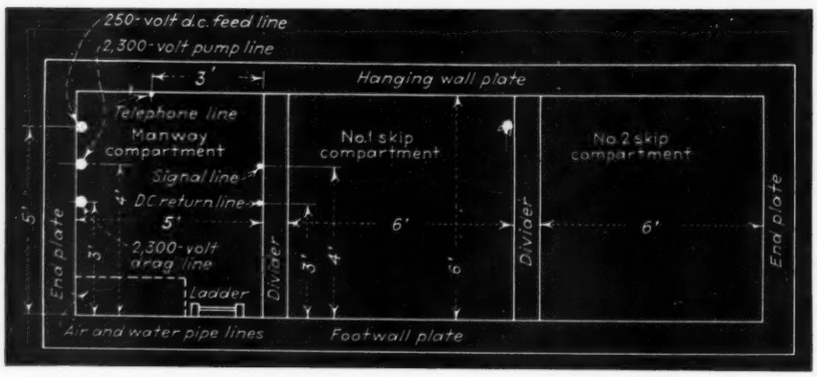


Fig. 20 . . . LOCATION OF POWER CABLE in manway of three-compartment shaft, Burra Burra mine, Tennessee Copper Company. A horizontal section is shown

Three 150-hp. motors pumping during the off-peak period constitute 450-

Table VI—Data for Cast-iron Pipe

Nominal Diameter of Pipe, Inches	Cost per Foot Cement Lining	Class A, 100 Feet		Class B, 200 Feet		Class C, 300 Feet		Class D, 400 Feet		Class E, 500 Feet		Class F, 600 Feet		Class G, 700 Feet		Class H, 800 Feet	
		Weight	Cost	Weight	Cost	Weight	Cost	Weight	Cost	Weight	Cost	Weight	Cost	Weight	Cost	Weight	Cost
4.....	$0.050	20	$0.65	22	$0.67	23	$0.71	25	$0.75	...	.....	...	....	...	....	...	.....
6.....	0.067	30	0.93	34	0.94	35	0.99	38	1.06	43	$1.25	45	$1.31	48	$1.40	50	$1.47
8.....	0.095	43	1.30	47	1.31	52	1.45	55	1.53	62	1.82	68	2.00	73	2.12	76	2.23
10.....	0.130	57	1.75	64	1.80	71	1.98	77	2.14	90	2.63	96	2.80	103	3.02	109	3.20
12.....	0.170	75	2.28	84	2.36	93	2.60	101	2.84	120	3.51	128	3.75	132	3.85	148	4.33
16.....	0.190	111	3.39	127	3.55	145	4.05	159	4.45	190	5.55	205	6.01	223	6.52	239	6.98
20.....	0.250	154	4.70	180	5.04	206	5.77	228	6.38	277	8.11	299	8.74	329	9.62	353	10.31
24.....	0.350	209	6.38	240	6.73	279	7.81	307	8.60	383	11.19	416	12.16	496	14.50	526	15.39

Table VII—Data for Wood Pipe

Maximum Pressures—Price Per Foot

	Diameter, Inches	100 Ft.	200 Ft.	300 Ft.	400 Ft.
Redwood	6	$0.57	$0.66	$0.75	....
Fir	..	0.44	0.49	0.54	$0.62
Redwood	8	0.67	0.79	0.92	....
Fir	..	0.56	0.63	0.72	0.82
Redwood	10	0.81	0.96	1.10	....
Fir	..	0.71	0.80	0.91	1.03
Redwood	12	0.97	1.21	1.44	....
Fir	..	0.83	0.99	1.14	1.31
Redwood	16	1.41	1.73	2.10	....
Fir	..	1.12	1.38	1.67	1.93
Redwood	24	2.26	2.97	3.75	....
Fir	..	1.87	2.48	3.03	3.56

Table VIII—Comparative Cost of Five Sizes of Pipe

Size Pipe, Inches	Cost of 850 Feet Pipe	Total Friction Head Including 4 Ells, 1 Valve	Kw.-Hr. Consumed by Friction	Cost per Year: Power at 1¢ per Kw.-Hr.	Cost per Year: Yearly Payments Including 6% Cumulative Interest	Total Cost per Year
6.....	$1,309.00	107.20	123,730	$1,231.73	$202.89	$1,434.62
8.....	1,972.00	27.80	31,942	319.42	305.66	625.08
10.....	2,830.50	9.60	11,030	110.30	438.73	549.03
12.....	3,825.00	4.10	4,711	47.11	592.87	639.98
14.....	4,955.50	1.70	1,953	19.53	768.10	787.63

Table IX—Friction of Water in Pipes

Loss of head in feet due to friction per 100 feet of ordinary cast iron pipe

Gals. per Min.	4″ Pipe		5″ Pipe		6″ Pipe		8″ Pipe		10″ Pipe		12″ Pipe	
	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.
40.....	1.02	0.22										
45.....	1.17	0.28										
50.....	1.28	0.34										
70.....	1.79	0.63	1.14	0.21								
75.....	1.92	0.73	1.22	0.24								
100.....	2.55	1.23	1.63	0.39	1.14	0.14						
120.....	3.06	1.71	1.96	0.57	1.42	0.25						
125.....	3.19	1.86	2.04	0.64	1.48	0.28						
150.....	3.84	2.55	2.45	0.88	1.71	0.32						
175.....	4.45	3.36	2.86	1.18	2.00	0.48						
200.....	5.11	4.37	3.27	1.48	2.28	0.62						
225.....	6.32	6.61	3.67	1.86	2.57	0.74						
250.....	6.40	6.72	4.08	2.24	2.80	0.92	1.60	0.22				
270.....	6.90	7.70	4.42	2.60	3.03	1.13	1.70	0.25				
475.....	7.03	7.99	4.50	2.72	3.06	1.15	1.73	0.27				
300.....	7.66	9.38	4.90	3.15	3.40	1.29	1.90	0.36				
350.....	8.90	12.32	5.72	4.19	3.98	1.69	2.20	0.41				
400.....	10.20	13.82	6.54	5.33	4.54	2.21	2.60	0.56				
450.....	11.50	19.74	7.35	6.65	5.12	2.74	2.92	0.64	1.80	0.21		
470.....	12.16	22.40	7.78	7.42	5.49	3.12	3.07	0.77	1.92	0.24		
475.....	12.30	22.96	7.88	7.22	5.55	3.21	3.10	0.79	1.94	0.25		
500.....	12.77	24.08	8.17	8.12	5.60	3.26	3.20	0.81	2.04	0.28	1.42	0.11
550.....	.....	.....	8.99	9.66	6.16	3.93	3.52	0.98	2.25	0.33	1.57	0.14
600.....	.....	.....	9.80	11.34	6.72	4.70	3.84	1.16	2.46	0.39	1.71	0.15
650.....	.....	.....	10.62	13.16	7.28	5.50	4.16	1.34	2.66	0.46	1.85	0.19
700.....	.....	.....	11.44	15.12	7.84	6.38	4.46	1.54	2.86	0.52	2.00	0.22
750.....	.....	.....	12.26	17.22	8.50	7.00	4.80	1.74	3.06	0.59	2.13	0.24
800.....	.....	.....	.....	.....	9.08	7.90	5.12	1.97	3.28	0.67	2.27	0.27
850.....	.....	.....	.....	.....	9.58	8.75	5.48	2.28	3.48	0.75	2.41	0.31
900.....	.....	.....	.....	.....	10.30	10.11	5.75	2.46	3.68	0.83	2.56	0.34
950.....	.....	.....	.....	.....	10.72	10.71	6.00	2.87	3.88	0.91	2.70	0.35
1000.....	.....	.....	.....	.....	11.32	12.04	6.40	3.02	4.08	1.01	2.84	0.41
1050.....	.....	.....	.....	.....	11.90	13.30	6.70	3.21	4.29	1.09	2.98	0.48
1100.....	.....	.....	.....	.....	12.50	14.31	7.03	3.51	4.50	1.20	3.13	0.49
1150.....	.....	.....	.....	.....	12.95	15.34	7.35	3.84	4.71	1.34	3.27	0.53
1200.....	.....	.....	.....	.....	13.52	16.69	7.67	4.26	4.91	1.46	3.41	0.57
1250.....	.....	.....	.....	.....	11.10	18.20	8.00	4.45	5.11	1.51	3.55	0.62
1500.....	.....	.....	.....	.....	.....	.....	9.60	6.27	6.10	2.09	4.20	0.85
2000.....	.....	.....	.....	.....	.....	.....	12.70	10.71	8.10	3.50	5.60	1.43
2500.....	.....	.....	.....	.....	.....	.....	.....	.....	10.10	5.33	7.00	2.18
3000.....	.....	.....	.....	.....	.....	.....	.....	.....	12.10	7.42	8.40	3.39
3500.....	.....	.....	.....	.....	.....	.....	.....	.....	14.10	10.08	9.80	3.92
4000.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11.35	5.32
4200.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11.93	6.30
4500.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.78	6.75
5000.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14.20	8.15

Vel.— Velocity feet per second. Fric.— Friction head in feet.

Friction of Water in 90° Elbows

Equivalent number of feet straight pipe

Size of elbow, inches	4	5	6	8	10	12
Friction equivalent feet straight pipe	16	18	18	24	30	40

Note — The figures given are based on the assumption that the total velocity head of the water flowing through the elbow is used up to overcome the friction.

hp. load. If operated during the peak period the average cost may be figured at $1 per horsepower-month, making $450 per month. This amount, $450, multiplied by 12 months makes $5,400 per year for the life of the station.

For a mine having 250-g.p.m. inflow and a pump of 800-g.p.m. capacity, with the peak period from 6 a.m. to 6 p.m., 12 hours' storage capacity must be provided to avoid the peak; and to allow for some settling 200,000-gal. additional storage should be provided. The actual running time is 7.5 hours for this pump, a total of 360,000 gal. being handled. In this case, 200,000 gal. × $0.0214 (cost of excavation per gallon) equals $4,280. Storage above the stated amount must be credited to labor savings and additional protection.

Though a 24-hour storage capacity of 360,000 gal. looks excessive, it would cost $7,704 at the same rate and would save an additional pump operator. Taken at $4.50 times 365 days, this equals $1,642.50 plus $5,400, or $7,042, which is the yearly saving made available.

Under the condition outlined in the foregoing the larger sump is advisable for any life of more than one year. Without the power demand being considered, the labor saving alone would require a much longer anticipated life. Hence the advisability of using a sump of a size greater than that needed for normal protection should be considered in each case.

Power Lines—Feeder wires and cables for underground power transmission should be given the best possible protection from water, spill from hoisting compartments, and from damage that may otherwise occur while the pipe line is being repaired or workmen are going through the manway. In many cases separate openings for the power lines, such as boreholes and raises, are warranted.

Fig. 20 illustrates the location of cables in the manway of a three compartment shaft. The discharge pipe and the power cables may be noted on the shaft timbers in the ladder compartment, the power line being as far away from the hoisting compartment and manway ladder as possible. The reason for this is to afford safety and maximum protection for the equipment. If the cable is properly selected, installed, and protected it should last indefinitely, inasmuch as failures of

Table X—Cost of Power

Power cost in dollars per year of 365 days, for one hour pumping each day, pumping 100 U.S.g.p.m. against one foot head, the efficiency of motor and pump combined. The cost of power being known.

To find the cost per year for any lift or rate per minute multiply head in feet by hundred gallons per minute, by hours pumping per day. Multiply the product by the value found opposite price paid per kilowatt-hour and pump efficiency.

Cost per Kw.-Hr.	Efficiency in per Cent Pumping One Hour per Day — 365 Days per Year												
	40	45	50	55	60	65	70	75	80	85	90	95	100
.002.....	.03447	.03064	.02757	.02507	.02298	.02121	.01970	.01838	.01723	.01622	.01532	.01451	.01379
.003.....	.05170	.04596	.04136	.03760	.03447	.03182	.02954	.02758	.02585	.02433	.02298	.02177	.02068
.004.....	.06894	.06128	.05515	.05014	.04596	.04242	.03939	.03677	.03447	.03244	.03064	.02903	.02757
.005.....	.08617	.07660	.06894	.06267	.05745	.05303	.04924	.04596	.04309	.04055	.03830	.03628	.03447
.006.....	.10340	.09191	.08272	.07520	.06894	.06363	.05909	.05515	.05170	.04866	.04596	.04354	.04136
.007.....	.12064	.10723	.09651	.08774	.08043	.07424	.06894	.06434	.06032	.05677	.05362	.05080	.04826
.008.....	.13787	.12255	.11030	.10027	.09192	.08484	.07878	.07353	.06884	.06488	.06128	.05805	.05515
.009.....	.15511	.13787	.12408	.11281	.10341	.09545	.08863	.08273	.07755	.07299	.06894	.06531	.06204
.010.....	.17234	.15319	.13787	.12534	.11490	.10606	.09848	.09192	.08617	.08110	.07659	.07256	.06894
.011.....	.18957	.16851	.15166	.13787	.12639	.11666	.10833	.10111	.09479	.08921	.08426	.07982	.07583
.012.....	.20681	.18383	.16544	.15041	.13788	.12727	.11818	.11030	.10341	.09732	.09192	.08708	.08272
.013.....	.24404	.19915	.17923	.16294	.14937	.13787	.12803	.11949	.11202	.10543	.09957	.09433	.08962
.014.....	.24128	.21447	.19302	.17548	.16086	.14848	.13787	.12869	.12064	.11354	.10723	.10159	.09651
.015.....	.25851	.22979	.20681	.18801	.17235	.15908	.14772	.13788	.12926	.12165	.11489	.10885	.10341
.016.....	.27574	.24510	.22059	.20054	.18384	.16969	.15757	.14707	.13787	.12976	.12255	.11610	.11030
.017.....	.29298	.26042	.23438	.21308	.19533	.18029	.16742	.15626	.14649	.13787	.13021	.12336	.11719
.018.....	.31021	.27574	.24817	.22561	.20682	.19090	.17727	.16545	.15511	.14598	.13787	.13062	.12409
.019.....	.32745	.29106	.26195	.23815	=21831	.20151	.18711	.17464	.16372	.15409	.14553	.13787	.13098
.020.....	.34468	.30638	.27574	.25068	.22980	.21211	.19696	.18384	.17234	.16220	.15319	.14513	.13787

conductor insulation are due almost entirely to overload or to external damage.

All feed lines from the shaft should be fused to protect the cable. Alternating current at approximately 2,200 volts is generally used in mines in the power feeder lines run in from the surface. Lower voltages are secured by stepping down with transformers at or near the motor to avoid line loss.

Underground conductors must also be safeguarded against falling rock and the usual unavoidable bumps that occur in a shaft. They must also be installed so that contact with the electric current by workmen is improbable. The specifications for high-voltage (in excess 500 volts) wires and cable demand adequate electrical insulation with metal protection. The armor is grounded according to standard specifications for grounding conduits, steel armored cables, lead-sheathed cables, and other metallic tubing systems. Conductors should be incased in grounded metal for protection of workmen against shock.

The following conductor material is available for shaft conditions: Marine cable, having both lead sheath and steel armor; steel-armored marine cable; lead-covered cable; and metal pipe conduit protection for individually insulated wires.

The marine-type three-conductor cable with cambric insulation, lead-sheathed and covered with a jute wrapper and galvanized round steel-wire armor on the outside, is in general use for shaft conductor. The steel armor is protected from rust and deterioration from acid water by a heavy asphalt paint. Maintenance of the armor lessens the value of the lead sheath, which gives excessive weight and adds about 22 per cent to the cost of the cable.

The submarine cable, Fig. 21, is recommended by users and several of the leading cable manufacturers. It is briefly described as having (1) conductor insulated with 30 per cent rubber compound and sufficient for the required voltage; (2) rubber-filled tape on each conductor; (3) conductors laid up with saturated jute filler; (4) rubber-filled tape over assembly; (5) 30 per cent rubber belt or hose of suitable thickness, depending on the size of the core; (6) rubber-filled tape; (7) asphalt bedding with a final covering of the round-wire-type armor, each wire to be heavily galvanized and covered with asphalt for an additional protection against the action of mine water. In acid conditions this armor should have a good coat of asphalt paint each year. This cable is greatly favored because the armor is of sufficient strength to support it, thereby relieving the necessity for many tight clamps. Where clamps are used on this cable in a wet shaft, the clamp and armor should be well covered with asphalt.

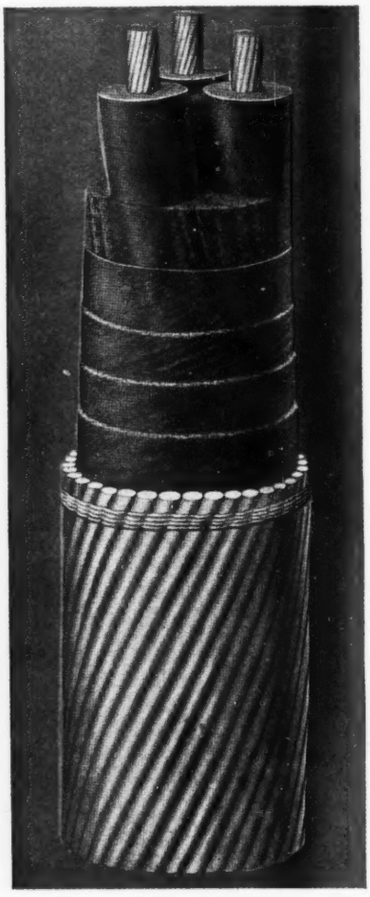


Fig. 21 . . . SUBMARINE CABLE, such as is recommended by some manufacturers and users for carrying electric power down a shaft

For severe acid conditions a lead-sheathed cable is preferred. Its life depends on the care in handling given to prevent damage during installation. A wide bearing clamp support should be used every 10 to 15 ft.

With any type of cable it is of the greatest importance to keep moisture out of the wire insulation. Uniform curves for drainage should be used in approaching or leaving the shaft.

The cost of submarine cable, as described, for 2/0-4000-volt insulation is about $1.35 per foot. The lead-covered cable for this size conductor is $0.95 per foot. Either of these lines should give at least fifteen years of dependable service. For a cheaper installation, rubber-covered copper wire in conduit is used. For a 2/0-3 conductor 3,500-volt rubber insulation in a 2-in. conduit one should expect from eight to ten years of service, provided the necessary precautions are taken to avoid damage during installation. The wires should be supported on an insulated hanger every 200 to 300 ft. Water should be kept out of pipe and junction boxes and drainage provided at the boxes. The outside of the conduit should be kept as free as possible of accumulations of corrosive materials at contacts with clamps and level floors.

The cost of 2-in. conduit is $0.28 per foot. That of 2/0, 3,500-volt insulated wire is $0.36 per foot for three wires, making a total cost of $0.64 per foot. The labor cost of installing the conduit system will average about 12c. per foot more than the submarine cable and the lead cable 10c. per foot more, making the comparative cost ratio about 135:105:76.

A.I.M.E. Convention Attracts Many In Mining Industry

Technical Meetings Draw Large Attendance

OFFERING the opportunity to attend informative technical sessions on modern practice in mining and metallurgy, members of the American Institute of Mining and Metallurgical Engineers recorded outstanding attendance at the 147th meeting, held in New York from Feb. 15 to 19. Members and delegates from many parts of the country reflected the cheerful condition of the mining industry, which took on more color when lead prices were boosted ½c., zinc 8c., and copper 1c. per lb. during the convention week.

Following registration on Monday, Feb. 15, members attended sessions on the metallurgy of lead and geophysical methods of prospecting, and those interested in coal mining discussed the acid mine water problems. On lead metallurgy, H. J. Stehli, of the Dwight Lloyd Company, discussed the advantages of double sintering the ore, which gives the result of a low-sulphur sinter, that makes little or no matte in the blast furnace and helps greatly to increase blast-furnace tonnage. Blast-furnace practice at Midvale, Utah, was told by Galen H. Clevenger, consulting metallurgist, United States Smelting, Refining & Mining Company. He presented the development and evolution of the plant, which now produces as much lead with one furnace as it did formerly with six. The paper by the late G. E. Murray, on the lead blast furnace at Trail, B.C., was given by J. Buchanan, who described the success achieved in widening a furnace, replacing eighteen 4-in. tuyeres with 36 2½-in. tuyeres, thereby increasing the smelting rate approximately 30 per cent. An interesting laboratory demonstration using sound waves of high frequency, send through a 4½-in. glass cylinder filled with fumes, to precipate the dust particles in the fumes on the side of the glass, was shown and explained by H. W. St. Clair, of the staff of the United States Bureau of Mines.

Milling methods papers included a description of a method for estimating pulverizer efficiency, described by R. Wilson; and ball-mill grinding, by W. H. Coghill and F. D. DeVaney. Reporting that recent years have indicated considerable research in lowering grinding costs, C. K. McArthur described the modern trends in classification. Mills described were the Achotla chloridizing mill in Guerrero, Mexico, by H. P. Allen, and the underground mill at Gilman, Colo., by W. O. Borcherdt.

The rapidly growing use of electrolytic zinc presented a timely subject, and Arthur Zentner discussed the world development of this method of obtaining high-grade zinc. Some of the plants described were Magdeburg Zinc Works, in Germany; the Risdon plant, in Tasmania; the electrolytic zinc plant of the Sullivan Mining Company, and the process of the Consolidated Mining & Smelting Company of Canada. A departure from standard practice in this method was the interesting paper presented by G. F. Weaton, on the St. Joseph Lead Company's electrothermic zinc-smelting process.

Discussion on mining methods included open-pit mining by trucks and conveyor belts, and function of power scrapers and dragline cableway excavators. The slot system of mining at the Golden Queen Mine, Mojave, Calif., was described by C. A. Kumke, and the progress with liquid oxygen explosives was told by George B. Holderer. J. B. Newsom described his new shaft-boring machine (*E.&M.J.*, Sept., 1936), which recently sunk a 5-ft. shaft 1,125 ft. deep at the Idaho-Maryland mine, in California. Concreting drifts at Ray copper mines, in Arizona, was considered in a paper by R. W. Thomas.

Safety and health in mining attracted large gatherings in view of legislative action under way in several states on the silicosis problem. D. Harrington, of the United States Bureau of Mines, described dust hazards and their control in mining. G. Norman, of Ontario, Canada, described methods of sampling and dust determination in Ontario mines. Many phases in handling the silicosis problem in Ontario were described by G. Bateman, and A. G. Lanza presented the physical aspects of the prevention and treatment of silicosis.

Sessions in mining geology included discussion on deposits of non-metallics and various metal deposits. A paper on the Slumbering Hill region, in Nevada, was presented, and the Tombstone, Arizona, mining district was also described. Other papers discussed the geology of the Buchans lead-zinc-copper deposits of Newfoundland and presented new data on the Wisconsin lead-zinc district.

Six engineers were recipients of highest awards for distinguished service in their respective fields of industry in 1936. The William Lawrence Saunders Gold Medal was given to Erskine Ramsey, consulting engineer, of Birmingham, Ala., for inventions used in coal mining. The first Anthony F. Lucas Gold Medal was presented to G. Edgar Pew, vice-president of the Sun Oil Company, for his vigorous promotion for standardization of oil-field equipment. George S. Rice, of the United States Bureau of Mines, was awarded the Certificate of Honorary Membership, for promoting safety in mining. The Robert W. Hunt prize was shared by William F. Holbrook, assistant chemical engineer, United States Bureau of Mines, Minneapolis, and Thomas L. Joseph, professor of metallurgy at Minnesota School of Mines and Metallurgy, for contributing the best original paper on Iron and Steel in 1936. John M. Hassler, chief engineer, Southern District Republic Steel Corporation, Birmingham, Ala., received the J. E. Johnson, Jr., award for work advancing the quality and preparation of raw materials for the blast furnace. The awards were presented by President John M. Lovejoy at the annual dinner at the Waldorf-Astoria. Herbert Hoover, former President of the United States and Saunders Medalist, 1928, was present and received a splendid reception when he briefly addressed the gathering.

Officers elected for 1937 were: president, Rolland C. Allen, executive vice-president Oglebay, Norton & Company. H. G. Moulton and Harvey S. Mudd, consulting engineers, were elected vice-presidents, and Karl Eilers was re-elected vice-president.

New directors elected were John M. Boutwell, mining geologist, Salt Lake City; William B. Daly, mines manager Anaconda Copper Mining Company, Butte, Mont.; W. M. Peirce, assistant to Chief of Research, New Jersey Zinc Company, Palmerton, N. J.; Brent N. Rickard, manager, El Paso smelter, A.S.&R.; and Lewis E. Young, vice-president, Pittsburgh Coal Company. Directors re-elected were Erle V. Daveler, treasurer, Utah Copper Company; G. B. Waterhouse, consulting metallurgist, Massachusetts Institute of Technology, and Louis Cates, president of the Phelps Dodge Corporation.

The Murray lead smelter of the American Smelting & Refining Company, in Utah, was forced to suspend operations beginning Feb. 10 owing to lack of ore and concentrates. This situation is a result of the miners' strike, which lasted from Oct. 12 to Dec. 16. Operations are expected to resume the end of March

Utah

Proposed 22,000-Ft. Tunnel, Bingham to Tooele

Utah-Apex stockholders to vote consolidation with Utah-Delaware, forming new corporation called National Tunnel & Mines Company—Depleted ore stocks temporarily close Murray lead smelter

▶ Believing a union of the companies will be advantageous, stockholders of Utah-Apex Mining Company and Utah-Delaware Mining Company have been urged to vote adoption of a consolidation agreement on March 12, to form the National Tunnel & Mines Company. The ore in the Utah-Delaware mine is principally lead-zinc, but copper ore averaging about 2.92 per cent copper, 0.101 oz. gold, and 1.32 oz. silver is also found. The property of the Utah-Apex Mining Company adjoins the Utah-Delaware on the north, in the West Mountain mining district, Salt Lake and Tooele counties. The ores of the Utah-Apex are also lead-zinc ores of two classes, the highest assaying 14.9 per cent lead and 12.2 per cent zinc. The copper ore is slightly lower than that in the Utah-Delaware. To facilitate exploitation for both properties it is proposed to drive a tunnel 22,000 ft. long, the portal in Tooele Valley near the milling and smelting plants of the International Smelting & Refining Company. The cost is estimated to be about $650,000.

▶ Employees of the International Smelting Company at Tooele received an advance in pay of 25c. a day, effective Feb. 1. Since the strike, settled in December, Utah miners have gained a net increase of 50c. a day. This includes the 25c. a day raise granted at the settlement of the strike and a similar increase on Feb. 16, bringing the Utah scale up to $5.75 a day for machine miners, which is equal to the Butte scale. A similar increase was made at the Midvale smelters of the United States Smelting, Refining & Mining Company.

▶ The Murray smelter of the American Smelting & Refining Company closed on Feb. 10 for six weeks, throwing about 300 men out of work. This is the result of a stoppage of shipments during the strike lasting from Oct. 12 to Dec. 16. It will take about six weeks to build up the ore stocks of the smelter, announced W. J. O'Connor, manager.

▶ Save for a brief shutdown at the Park City Consolidated Mining Company's property at Park City, when men went on a strike because of alleged discrimination against three old employees, all mines have been working steadily. Trouble at the Park City Consolidated was quickly adjusted by conferences between officials of the International Union of Mine, Mill and Smelter Workers and officials of the mine.

▶ Net income of the Silver King Coalition Mines Company for the year ending Dec. 31, 1936, amounted to $769,405.06, or 63c. a share. Valuation of stored concentrates at the market instead of cost would have increased net income to $815,792.74, or 67c. a share. Because of dividend payments and depletion, there was no surtax liability on 1936 undistributed profits. Income for the fourth quarter were reduced by the strike to a net profit of $119,422.54 after all taxes and depreciation, but before depletion, or to 9.78c. a share. Seventy-one per cent of the operating time lost by the property during the final quarter was caused by the shutdown during the strike.

▶ The contract for construction of a mill at the Lakeside Monarch Mining Company's plant, 17 miles north of Delle, was awarded recently to the Eimco Corporation, of Salt Lake City, according to George H. Short, manager. Construction work has begun. The mill is to be completed by May 15. Equipment will consist of a jaw crusher, a cone crusher, a 4-ft. rod mill, Deister tables, and flotation cells. Power will be supplied by a 300 hp. diesel engine, directly connected to a 250-kva. generator. Water will be brought through a 4-in. pipe from a well, two miles east of the mine.

▶ Raising on a highly mineralized formation has been started from the 1,350 level of the King David shaft, in the Frisco district, near Milford. The raise is now 290 ft. above the level in territory west of the shaft. Raising will be continued to a point 400 ft. above the 1,350 level. From this point, the company will crosscut to the shear zone cut by fissures believed to belong to the Horn Silver vein system.

▶ The Alta United Mines Company, at Alta, Little Cottonwood Canyon, 25 miles southeast of Salt Lake City, plans to resume operation in the spring by extending the Quincy Drain & Transportation Tunnel to the Wellington orebody, 300 ft. distant. The Rustlet orebody also will be entered at a depth of about 600 ft. on these deposits. Ore carrying about 3 per cent bismuth, 1.7 per cent copper, 14.5 oz. of silver, and 0.065 oz. of gold to the ton was opened up by development work during the summer, according to the report of George H. Watson, president and general manager.

MEETING OF AMERICAN ZINC INSTITUTE

THE NINETEENTH ANNUAL meeting of the American Zinc Institute, Inc., will be held at the Hotel Statler, St. Louis, Mo., on April 26 and 27. A report of the year's activities of the Institute will be presented and Washington news as it affects the zinc industry will be interpreted. It is planned to present as a special feature, "The Outlook for Zinc Mining and Smelting." The program on the second day will give an intimate picture of new developments on the merchandising branch, and on the production of zinc and zinc-coated products.

THOUGH THE INSTITUTE'S meeting ends on the evening of the second day, April 27, the Galvanizers Committee, which is sponsored by the Zinc Institute, will carry its own program through Wednesday, April 28.

Nevada

Treadwell Yukon Mill Starts Operation

Cold weather has retarded reopening plant until March—Properties in Royston district acquired under option

▶ Clearing weather has enabled resumption of mining and milling in a number of Nevada districts in which much work was tied up for several weeks by cold and by heavy snows. The 300-ton flotation mill of the Treadwell Yukon Company, Ltd., at Tybo, Nye County, was scheduled to resume crushing ore by March 1, according to William Blackburn, manager. New orebodies have been opened in deep levels.

▶ Silver-gold properties in the Royston district, 28 miles north of Tonopah, in Nye County, have been acquired under option by a group of Utah men, headed by William Cleghorn, with headquarters at Tonopah and operating as the Royston Coalition Mines Company. The Hudson group, of Salt Lake City, formerly owned a large part of the district, including ground embraced by the productive Betts lease.

▶ A new ball mill has been delivered at the flotation mill of Sierra Nevada, Ltd., at the north end of the Comstock lode near Virginia City. The mill has been enlarged from 150 to 300 tons per day and treats ore from mines on Cedar Hill. Arthur Thomas is president.

▶ Suspension of all service by the Goldfield Water Company faced the Goldfield district with a serious water problem. The supply has been piped heretofore 35 miles from near Lida, to the southwest. A temporary supply is available from pipes of the Bradshaw Syndicate.

▶ Construction of a 75-ton mill is in progress at the Southgold property, near Eden Creek, 65 miles east of Tonopah, in Nye County. A 2,500-watt Delco light plant was provided recently by C. R. Terrell, manager.

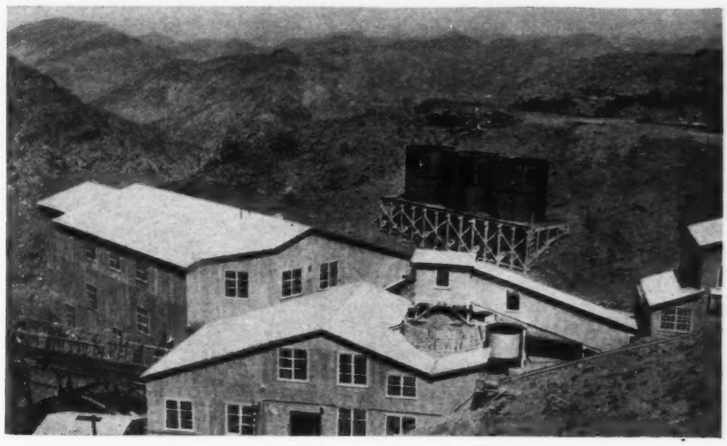
▶ Active work has been started on the Gold Cash claims near Battle Mountain, purchased lately by H. C. Bishop and Denver associates. The claims have produced 18 cars of high-grade smelting ore within the past two years. A. M. Most, of Denver, completed the transaction.

▶ Members of the Nevada Mine Operators Association, meeting in Reno recently, elected all former directors, including J. C. Kinnear, of the Nevada Consolidated Copper Company; H. A. Johnson, manager for the Tonopah Mining Company; E. A. Julian, head of the Goldfield Consolidated Exploration Company; H. T. Huffer, Henry M. Rives, L. D. Gordon, N. H. Getchell, Fred L. Cole, W. H. Blackburn, and J. B. Haffner.

▶ A cyanide mill completed lately at the Chiquita mine, in southern Clark County, is reported to be treating a capacity load of 100 tons per day, with power supplied by a new diesel plant. Ore of good mill grade is said to be blocked on levels from the 500 to the 1,100.

▶ Suit has been filed in the Mineral County district court to foreclose a lien on the Kernick 50-ton mill, operated for the past year or more by the W. M. Mining & Milling Company. F. P. Merry is trustee and manager for the mill company. The lien action was brought by ore hauling contractors.

▶ The Arizona Comstock Corporation, at Virginia City, produced flotation concentrate and bullion in 1936 having a value of $456,178.53, or $64,000 more in value than in 1935, according to a report by W. J. Loring, president and managing director. The auxiliary cyanide plant produced bullion worth $15,166, having been put in operation only late in September. Nearly all ore continued to come from the huge open cut on the lode outcrop.



The 100-ton cyanide plant of the Chiquita Mining Company, Ltd., Goodsprings, Nev., is now operating at capacity, receiving a good grade of ore from stopes between the 500 and 1,100 levels

Colorado

Prospecting North of Mollie Kathleen

Properties planned to be developed from a crosscut now under way from the company's shaft—Ajax shaft now down to 2,400 feet

▶ Mrs. Verner Z. Reed and associates, of Denver, having maintained a $100,000 mining development program on the Mollie Kathleen, are now starting a drive into Tenderfoot Hill. They expect to develop the Sangre de Cristo, the Queen Bess, the Black Diamond, and the Hill Top properties, lying north of the Mollie Kathleen. This company has done considerable development work in the northern section of the camp.

▶ The Ajax shaft is now at a depth of 2,400 ft., and sinking will be continued to the 2,650-ft. level. About 3,600 g.p.m. of water are being pumped to the Roosevelt Tunnel. Pumping costs for the year averaged a high figure. The ore in the Newmarket vein above the 23d level is reported to be of excellent grade.

▶ The International Gold Producers, operating the Logan mine, on the Stratton estate, mined 23,245 tons of ore in 1936, having an average value of $10.53 per ton. The ore was shipped to the Cripple Creek Milling Company. This represented nearly 50 per cent of the ore mined on all of the Stratton properties.

▶ The Yellow Bird Mining Company, in Bassam Park district, Chaffee County, has started crosscutting on the 100-ft. level. Some favorable ore is reported in this development. The vein is considered an extension of the Alma vein, as the ore closely resembles that found on the South London property. The mine is operated by G. L. Breithaupt and the three Franklin brothers.

▶ Robert E. Landon, consulting geologist and mining engineer of Colorado Springs, has been appointed general manager of the American Eagle Properties, Inc., and the Western Leasing & Mining Company. A shallow shaft has been sunk on the Hartman lease on a strong vein, said to assay $200 per ton. A new headframe and screening plant have been erected.

▶ The Dollie Varden shaft, on the northwest slope of Raven Hill, has been sunk 300 ft. and will be continued to 600 ft. New buildings have been erected and new machinery has been installed. J. O. A. Carper is president and A. F. Carper is superintendent.

▶ The Anchoria Leland shipped 4,015 tons of ore in 1936, of an average value of $14.97 per ton. Total value of ore shipped from the Cresson was $439,589.74 in 1936.

Idaho

Sunshine's Jewell Shaft Connects at 23d Level

Good ore reported found in mine of Gibbonsville Mining & Exploration Company—Heavy snows cause damage and loss of time to mining companies in Coeur d'Alenes

▶ Connection with the new four-compartment Jewell shaft with the 2,300 level workings has been accomplished, which will afford stepping up of ore haulage to keep the mill running at capacity. A raise from the 2,300 level of the Sunshine mine has cut into ore said to contain a good grade of silver. The ore containing high grade is said to be about 3 ft. wide with about 5 ft. of lower-grade ore in the vein.

▶ Seven feet of milling ore with streaks of high grade are said to have been found in the crosscut at the property of the Gibbonsville Mining & Exploration Company, in central Idaho. Headquarters of the company are at Kellogg, with Philo Seelye as manager of the mine.

▶ A diamond-drill hole, driven from the No. 5 tunnel of the Mineral Point mine of the Coeur d'Alene Mines Company, has penetrated a vein said to indicate a width of 13 ft., carrying high silver values, according to reports made in Wallace. The vein at this point is 1,000 ft. vertically below the surface and 1,540 ft. deep on the dip of the vein. Dan Leary, of Wallace, is managing director, and Jean Peters, mine manager. Herbert C. Mowery, Wallace, president of the company, states that a shaft will be sunk on the best showing of the vein indicated by diamond drilling.

▶ Snowslides in the Coeur d'Alene mining district during the past two weeks have caused considerable damage and loss of time to a number of mines, taking out power lines to several properties. At the Silver Strike property, east of Murray, L. W. Defenbach, manager, had a narrow escape from injury when a huge slide came down within 100 yd. of the company's office, burying the road and gulch under 50 ft. of debris.

▶ The Argentine property, two miles west of Wallace, in the silver belt, is expected to start work soon under a new syndicate arranged by Rush J. White, mining engineer, who has held the mine under lease and bond for some time. Mr. White plans to explore the Argentine vein system at depth and has been negotiating for the use of the Vulcan tunnel of the Callahan Zinc-Lead Company.

▶ About 50,000 tons of ore have been shipped from the Triumph mine, in the Hailey district, since last spring, according to Neal Snyder, manager, representing approximately $750,000 gross income to the operators. Plans are under way for the construction of a mill.

VIEWS ON ANNUAL ASSESSMENT WORK

SEVERAL HUNDRED MEMBERS of the Great American Prospectors Association, with offices in Salt Lake City, Utah, recently authorized their executive committee to pass the following resolution on annual assessment work on unpatented mining claims:

WHEREAS the moratorium on annual labor on unpatented mining claims has been in force for several years and this exemption has been very helpful to the prospector during the depression and has saved his claims for him, for which he is very grateful to Congress; and,

WHEREAS this association now feels that the depression is clearing to the extent that this moratorium is no longer necessary or advisable and should be discontinued;

THEREFORE BE IT RESOLVED, That The Great American Prospectors Association hereby urgently requests all members of the Senate and House of the Congress of the United States not to further extend the exemption of annual labor on unpatented mining claims.

Iron Country

Companies Prepare for Record Season

Present rate of ore consumption is around 4,500,000 tons monthly—Oliver Iron Mining Company buys seven electric power shovels

▶ The regular winter repair work is being conducted at practically all mines. The shops are carrying on a more extensive program than has been in progress for several years. Equipment is being overhauled in order that maximum production can be secured in case of necessity. All mining companies expect to produce maximum schedules this season, and if the independent mining concerns ship in the same percentage as last season it will keep them going at a record-breaking pace.

If the iron-ore movement is analyzed, it is noted that ore on hand Jan. 1, 1937, shown by the Lake Superior Ore Association is 31,402,148 tons. This includes ore on hand both at docks and furnace yards. In December, 1936, consumption was over 4,500,000 tons, and if this rate is maintained to May 1, consumption would be 18,000,000 tons for the four months of 1937. This would leave a balance on hand of only 13,000,000 tons, which would be lower than at any other recent time. In 1929 the May 1 balance showed about 16,000,000 tons.

▶ The Great Northern Railway Company has made a survey of probable shipments over its road and estimated 18,000,000 tons for 1937. This would break all records over this railroad. Some definite tonnages are being forecast at various mines, viz., Mahoning Mine, 4,500,000 tons, and the Hill Annex, at Calumet, Minn., 2,500,000 tons. These properties will be the largest shippers of the Independent Mining Companies.

▶ The Oliver Iron Mining Company has placed orders for seven electric power shovels. Two 5-cu.yd. and two 4-cu.yd. shovels will be purchased from the Bucyrus Erie Company, and two 2¼-yd. and one 4-yd. from the Marion Steam Shovel Company.

Montana

Ermont Mine Labor Difficulties Settled

Seven-day strike adjusted by granting wage increase—Beaver Creek mine, in Little Rocky district, to be reopened

▶ The 60 men employed at the Ermont mine, near Argenta, 12 miles west of Dillon, who went on strike Feb. 6, have returned to work under an adjusted wage scale. An increase of 50c. a day brings the present schedule to $4.50 and $4.75 a day for miners and millmen respectively. Mayor D. A. Galt of Dillon, acting as arbitrator, and R. B. Caswell, general manager and part owner, conferring with a committee of miners, effected the settlement in seven days.

▶ Under the supervision of William Price, fifteen men have begun work reopening the Beaver Creek tunnel and reconstructing the mill foundation. The mine is several miles northwest of the Ruby Gulch operation in the Little Rocky district near Zortman. It is planned to rebuild a 200-ton cyanide mill early this season. Among the owners of the property are Mrs. Charles Whitcomb, T. A. Marlow, of Helena, and others.

▶ During the latter months of 1936 operating conditions at the Spring Hill mine, near Helena, were evidencing a marked improvement. The smelter returns reported for December were approximately $30,000, which establishes a new monthly record.

▶ The Taylor Nelson Knapp Corporation has acquired options on the Broadway, Victoria, and other adjacent claim groups in the Silver Star district of Madison County, Mont. A 7-mile power line has recently been completed from the Pulver mine, near Twin Bridges, to the property, and machinery is now being installed to unwater the Old Broadway workings, idle for many years, and extend developments.

NEWS FROM Washington

By Special Correspondent

LEGAL BATTLES before the Supreme Court have never been so bitter as those which surround it since President Roosevelt proposed judicial reforms. No legislative earthquake of comparable intensity or duration has occurred in Washington in many years. Social and economic structures have been shaken to their foundations.

Most observers believe that the present disturbance, regardless of the first outcome in Congress, is but one of a series. Regardless of the size of the Court, there will remain the question of constitutional amendments. And that subject will furnish sufficient area for a half dozen major campaigns of controversy between reform and conservative groups. Moreover, alignment of the groups is likely to change with each variant of the "reform" proposals.

"Anti" Coalition

OPPONENTS of the proposal to pack the Court by adding six younger justices can agree on opposing this idea of the President's, although they may commonly disagree on almost every other economic theory. One could hardly find three Senators less likely to join forces in a battle than Norris, Glass, and Connally. But this issue ranks these three shoulder to shoulder in the forefront of the opposition.

It is not uncommon to find that many diverse elements coalesce in opposition to a common foe. This type of coalition has made possible a really effective fight on the part of the President's opponents. Few, if any other, issues could have been raised which would have so seriously put in question the President's invulnerability.

Those who fear constitutional amendments quite as much as they resent indirection as a means of reaching "constitutionality" are encouraged but not happy about this situation. They know that efforts for revisions of the Constitution are bound to come later, regardless of the outcome of the present battle. And when such time comes, men like Norris will undoubtedly join the President, because Norris believes that certain further Federal authority is essential.

C. I. O. Vs. A. F. of L.

WASHINGTON DEBATES endlessly the significance of General Motors labor battle. If a dozen "experts" gather around a table to discuss the implications of the strike and its preliminary settlement by Governor Murphy, there are sure to be twelve opinions as to just what the results mean.

But there appears to be one point on which there is rather general agreement. Industrial unions gained a considerable victory over craft organizations. This conclusion is far more generally accepted than the other one on which there seems to be a majority agreement; namely, that John Lewis, C.I.O. leader, won a personal victory of great magnitude.

With respect to one negative matter having large importance for every mining and mineral industry executive is the doubt which continues regarding sit-down strikes. The illegality of these under many, if not most, laws, does not reduce the importance of the issue which they raise. As in military battles, the effective weapon is likely to be chosen during strikes regardless of pre-conflict agreements. And the sit-down strike is, Washington believes, the most effective one which the union organizers have yet devised for dealing with large-scale industry.

Federal officials will probably deny that they condone the use of this measure when local laws make it illegal. But no one denies that Federal officials, including the President, virtually demanded that General Motors negotiate without awaiting the removal of sit-downers. Impartial observers of Washington, if anyone deserves that name, therefore conclude that the Administration officially recognizes this strike technique as a part of approved strategy.

SILVER LOSSES

SECRETARY MORGENTHAU recently reported to Congress that he had spent $1,100,000,000 in buying silver at an average price of 60c. an ounce. This includes purchases of domestic production at about 78c., a quantity of silver nationalized at 50c., and the other purchases made in the effort to establish a 3 to 1 ratio between gold and silver metallic reserves. More significant than these statistical facts are the two important failures of the Treasury. Despite the huge purchases reported, the world price of silver is today just what it was when the silver-purchase act was enacted. Furthermore, the present ratio of gold to silver reserves remains approximately 5 to 1, just what it was when the buying program began. One Washington editor notes, "It is a case of running very hard in order to stand still." Secretary Morgenthau did not categorically recommend a repeal of the present silver-purchase law, nor demand authority to lower the price paid for virgin domestic silver. But he makes no secret of his wish that he might have both those changes of the law.

SILVER STATE SENATORS will oppose. It seems likely that they will continue to be able to hold the present laws in effect; certainly they will so far as the bonus in price on domestic production is involved. But the Treasury may be given some measure of relief with respect to further buying of foreign supplies, in its effort to build up silver stocks in the Treasury. The confession that Uncle Sam has already lost $275,000,000 in this effort may be enough to secure relief when there are rudimentary desires for economy beginning to show life in Washington.

Uncle Sam, Steel Maker

SERIOUS CONSIDERATION is being given to the proposal that Uncle Sam make his own armor plate at an existing small steel plant owned by the Government at Charleston. Such a step seems even more futile than unlikely. If the Administration should choose to use that means for securing alloyed steel for naval construction, without violation of the Walsh-Healy Law, the results would be far from sufficient to accomplish the President's purpose. The output of such steel could not be raised to significant levels without months of preparation and probably numerous unanticipated delays. And the total quantity of steel which could be so made is not sufficient to be a real club over the steel industry, which continues to resist complete unionization and drastic shortening of labor to 40 hours per week.

While other industries continue to be such good customers for the commercial steel men, they would probably not consider Uncle Sam's entering into the field as of any tremendous importance. In fact, one or two Washington observers opine that such effort might be a good thing for the industry. They reach such anomalous conclusion as follows: Uncle Sam would be a poor steel maker. His costs would be high. He would have even more labor troubles than the present employers, though they doubtless would be of an entirely different type. As a consequence the present steel managements would appear very favorably by comparison with Government manufacture.

Washington does not believe that this reasoning, however sound, is going to make steel executives invite Uncle Sam into their industry as a competitor.

New Dust Control

USING SOUND WAVES of higher frequency than are commonly audible, investigators of the Bureau of Mines have devised a new technique for controlling smoke and fumes. First small-scale laboratory demonstrations of this project were made in mid-February in Washington, followed by other demonstrations at A.I.M.E. meetings in New York.

This method, devised by H. W. St. Clair, of the Bureau of Mines, uses vibrations of high frequency, in the supersonic range, to produce standing waves

in the conduit through which dust, smoke, or fumes are passing. The wave length chosen must be approximately equal to the diameter of the conduit, which means that frequencies from 3 to 20 kilocycles per second would be required for industrial chimneys or conduits of normal dimension. Public service patents are being taken by the Bureau investigators. It is hoped that commercial-scale trials will be carried out in the near future.

Mineral Policy

IT HAS BEEN PROPOSED to Brookings Institution, Washington, D. C., that it undertake a broad study of economic problems affecting mining and the mineral industries. Those who advocate such a plan feel that a fundamental inquiry of this character would be valuable to public officials as well as to the industry. The argument for having the work done at Brookings Institution, rather than by the Government, is, of course that such agency could not be accused of undertaking to create new Government projects requiring new appropriations for itself.

Furthermore, there would be no partisan questions raised by the program of this independent agency, even when matters of policy or opinion were under study. It might even develop, therefore, that *some* of the information required would be made available to the Brookings Institution more readily than to fact-finding Government bureaus, as it would not later become available for general access as in official records.

The Brookings Institution has not yet announced any decision regarding the matter; but the advocates of the plan are hoping that work may be actively undertaken soon. Obviously, the project will require many months for completion; possibly as much as three years. It seems evident that it will not be undertaken unless the full expected cooperation of Government bureaus concerned has been pledged. Another prerequisite may be that the National Resources Committee also be consulted and be found agreeable to such a "planning" study.

Mine executives who sought a more comprehensive effort by the Planning Committee for Mineral Policy are expected to welcome this proposal. If undertaken, the project would cover substantially the same area as the earlier official effort. It may, in fact, be carried forward with many of the same leaders as served in the previous undertaking.

Speeding Patent Cases

THE CONSIDERABLE EFFORT of patent advisers to industry and of the patent practitioners of Washington crystallized a year ago in a proposed bill to create a single Court of Patent Appeals. That bill has again been introduced in the present Congress by Senator McAdoo and may be considered before long by the Senate committee on patents. The prime purpose of such legislation would be to establish a single court to which all appeals from Federal district courts would come, instead of having these appeals heard as now in the various Circuit Courts of Appeal.

The proposed bill would set up the new court with five justices, selected because they "shall have demonstrated special aptitude in the practice or administration of the patent law before or in the United States courts." In effect, this would create a new circuit court with headquarters in Washington. Such a single review is intended partly to obviate conflicting opinions in different circuits, partly to give greater finality to the first appellate review. Incidentally, the proponents hope that fewer cases so reviewed would have to go still higher to the Supreme Court.

Among the novel features of the proposed law is the idea that this court would have three scientific advisers "each of whom has demonstrated aptitude in scientific and technological fields." These would be appointed by the court to serve at the pleasure of the court and to "act in an advisory capacity to said court in accordance with directions or assignments from the presiding judge."

A considerable number of scientific and technical bodies have endorsed the idea of the establishment of such court. However, that commendation of the single-court idea is often accompanied by a sharp criticism of the proposed plan for scientific advisers. This is based on the thought that these aids would in an *appellate* court work in chambers, undertaking to assist the jurists without affording opportunity for examination or cross-examination by the interested litigants. Critics point out that such advisers would have a very different status than in a *trial* court, for which they have often been recommended.

NAVAL RACE

WASHINGTON takes seriously John Bull's proposal to spend $7,000,000,000 for enlarged armament. Officials deny that Uncle Sam will enter into a navy-building race, but at the same time high officials insist that this country will have an adequate Navy. All this means huge new spending for metals and other mineral products important in ship construction. This naval problem spotlighted again the Government difficulty in buying copper, steel, and other commodities within the limits placed by the Walsh-Healy Law. Permission to secure special purchases of copper without compliance with wage-and-hour limits of N.R.A. days, as previously reported in these pages, did not represent a sufficient change in administration policy to permit all necessary purchases for accelerated construction.

THE PRESIDENT personally is demanding that the Navy Department speed up its building program, and he will have his way in this. It will probably be necessary in some further measure to sacrifice Walsh-Healy regulations by negotiated purchases of important metals. But this does not represent any intention of the Administration to abandon that means for forced shortening of hours in factories making goods for Uncle Sam.

Silicosis

FOUR important committee reports on various phases of the silicosis problems of industry were presented at the Second National Silicosis Conference held in Washington early in February. The mining industry was generously represented in the various studies, which dealt with engineering and medical methods for prevention, the economic and legal aspects, and regulatory and insurance problems.

Those engaged in this work seem generally to agree that additional educational effort among executives and employes of dusty industries will be far more important than added scientific research or more legislation. It does appear, however, that most believe that silicosis should be made one of the industrial hazards compensable under State acts for protection of industrial employees. Proponents of that plan believe that the same compensation should be granted to those suffering from silicosis as for other types of accidental disability.

Bureau of Mines and the United States Public Health Service are continuing to cooperate with the Department of Labor formulating information required. In general there appears to be adequate information available in order to guide affected industry in the establishment of wholly effective methods for medical and engineering control. An interesting economic aspect of the problem was presented by one of the committees, from whose report the following tax comment is taken:

"Another aspect of dust control measures which needs special reference at this time is their relation to the Federal tax on undistributed earnings. Dust control equipment is largely a capital expenditure, which cannot be charged as an operating cost but must be paid for out of net earnings or accumulated surplus. The present income tax law assesses a graduated surtax upon earnings used for purchase of such equipment, and thus increases its cost by as much as 27 per cent. It thus places the smaller concerns, most of which must depend on current earnings, at a marked disadvantage as compared with the larger concerns which can draw upon accumulated surplus. The subcommittee recommends a modification of this law to permit current earnings to be applied to capital expenditures, such as the installation of safety and dust control equipment, without incurring a penalty tax."

California

Mill Erection Continues At Good Pace

Several plants will contribute more gold to this year's production—Walker plant operating at capacity

The 1,000-ton cyanide mill of the Kennedy Mining & Milling Company at Jackson, Calif., has been temporarily shut down for repairs. Mill tailing is hydraulicked into a central pump sump, where it is distributed to leaching tanks by sand pumps

▶ Uniformly good progress is being made at the Confidence mine, 12 miles northeast of Sonora, in building the new 150-ton cyanide-flotation mill, which is being erected under contract by Western-Knapp Engineering Company, of San Francisco. Mine-run ore will be crushed in two stages by a Blake type jaw crusher and a 2-ft. Symons cone crusher, with a vibrating screen between the two units. Grinding will be done in cyanide solution in a 6x8-ft. ball mill in closed circuit with a Bendelari jig and a Model D Dorr classifier. The cyanide section of the mill is of the countercurrent type. Underflow from the last secondary thickener is treated in four Fagergren cells, the concentrates going successively to a thickener, an agitator, and a regrind unit consisting of a 3x8-ft. mill and a Model C Dorr classifier. Slimed concentrate returns to the primary thickener. The property is owned and operated by the Confidence Gold Mining Company, C. T. Eastman, manager.

▶ With four sections of the concentrator operating at capacity, Walker Mining Company is treating about 1,200 tons of ore a day, with 450 men employed under the direction of L. F. Bayer, superintendent. The deep snow and cold are said to have forced no curtailment of operations and delivery of concentrate has continued over the 9-mile aërial tramway to Spring Garden.

▶ Valley Gold Mines, Inc., plans early operations at its properties in the Willow Valley district, near Nevada City, which include the Belfountaine, LeCompton, St. Louis, Constitution, Federal Loan, and Any Port in a Storm. Last year the Belfountaine shaft was rehabilitated, and the stamp mill at the St. Louis mine, equipped with amalgamation and flotation units, was reconditioned. Installation of a tramway between the Belfountaine and St. Louis mines is contemplated. J. M. Hoff is in charge of operations.

▶ Rehabilitation of one of the main tunnels at the historic Plumas Eureka mine, near Johnsville, closed since 1885 by cave-ins, is progressing satisfactorily. A distance of 700 ft. has been cleared and retimbered, and exploration of new territory is planned. Total length of the adit is 7,000 ft. A 20-stamp mill is available for milling. The property is now controlled by the Plumas Eureka Mines Company, H. O. Harrison, president.

▶ With the 1,250-ft. shaft at the Norambagua mine, near Grass Valley, completely rehabilitated, Campbell California Mining Company has commenced underground development work to determine the extent of known orebodies. Connection of the shaft with the Perrin mine, to the west, also under lease to the company, is contemplated, and a 100-ton mill may be installed later if results of the development campaign are satisfactory. Marshall D. Draper is in charge of operations.

▶ Operations are to be resumed at the Bullion mine, south of Grass Valley, following settlement of legal differences between the owners of the mine, the Grass Valley Bullion Mining Company, and Empire Star Mines Company, Ltd. Production will be trucked to the Idaho Maryland mill for treatment.

▶ Mining operations have been resumed at the Duchess mine, near Carson Hill, by the Duchess Mining & Milling Corporation, J. S. Ward, president. Preliminary work in progress includes the rehabilitation of the 1,700-ft. main working tunnel, which is to be extended another 500 ft. later.

▶ Plans have been completed by Cactus Queen, Inc., for the installation of a 100-ton combination cyanide-flotation mill at its property on Middle Buttes, near Mojave. It is also reported that the parent company, the Kimball-Kempe Syndicate, Ojai, Calif., has exercised its option on the adjoining Blue Eagle claims owned by Fred Wright and J. A. Otto. Roy W. Moore, 1206 Pacific Mutual Building, Los Angeles, is general manager of Cactus Queen, Inc.

▶ According to reports from Grass Valley, Empire Star Mines Company, Ltd., has purchased the North Banner group of claims south of the Murchie mine, near Nevada City, and the Bridges property. F. W. Nobs is general manager.

▶ The Amador Mother Lode Mining Company has recently placed in operation the reconditioned Fremont mill, near Drytown. Equipped with modern crushing, grinding, and flotation machinery, the plant is currently treating 200 tons of dump material a day. The holdings of the company include the California, Fremont-Gover, and Seaton groups, extending about 10,000 ft. along the Mother Lode between Jackson and Plymouth. E. A. Stent is general manager.

▶ Milling operations have been suspended by Kennedy Mining & Milling Company, Jackson, to allow repairs and development work to be carried on to the north and south on the 5,400-ft. level. About 70 men will remain on the payroll under William Sinclair, superintendent.

▶ Columbus Gold Mining Company, D. J. Murphy, president, operating the Columbus mine, near Tuolumne, has ordered a new 60-ton flotation plant to replace the 10-stamp mill now in use. Other improvements to be made in the near future include the erection of a 60-ft. headframe, an ore bin, and possibly a cyanide plant for treating flotation concentrate. R. P. O'Brien, manager, is directing operations, which employ some 45 men under J. B. Sivori, superintendent.

SEC HAS NEW MINING FORM

NEW MINING companies seeking registration with the Securities and Exchange Commission may now use Form A-O-1. These forms and the accompanying instruction book are available for distribution.

THE FORM has been printed with space left for answers to the items, so that it may be used for filing registration statements if registrants so desire.

This modern 300-ton plant of the United States Smelting & Refining Company, at Gold Road, Arizona, recently started operations treating ore containing finely divided gold in quartz and calcite. Fine grinding and the all-sliming process is used

Arizona

300-Ton Gold Road Mill Starts Operations

New plant treats ore formerly sent to Tom Reed mill—Gold Standard Company stepping up production—Bullwhacker Mine to be reopened

▶ The Gold Road mine, property of the United States Smelting, Refining Mining Company, 20 miles west of Kingman, started its 300-ton reduction plant on Feb. 15. In the pre-War period the mine produced several millions in gold. During the past year it has been hauling 1,500 tons monthly to the Tom Reed mill, at Oatman, for treatment. L. H. Duriez is in charge of operations.

▶ The Sunbeam Gold Mining Company, of Florence, operating the Bell-Martinez mines, recently shipped its first carload of concentrates to the El Paso smelter, and is now shipping a carload at ten-day intervals. The mill is treating 40 tons of ore daily. The company is constructing a new road, to ship from Superior, thereby shortening the hauling distance from 19 to 10 miles. H. A. Derrer is superintendent at the mines, and operations are directed by Glenville A. Collins, of 490 Bay St., San Francisco.

▶ Additional equipment has lately been added and the production increased to about 2,200 tons of gold ore monthly at the Octave mine, worked by the American Smelting & Refining Company. The operations are made under a profit-sharing agreement with the Arizona Eastern Gold Mines Company. M. E. Pratt, of Octave, is superintendent.

▶ Plans are being made to increase the tonnage from 250 to 350 tons daily at the milling plant of the Gold Standard at Katherine. It is also planned to increase the daily tonnage another 100 tons in the near future. Ore is now being supplied from the Portland, Arabian, and Philadelphia properties, all controlled by the Gold Standard Company. Richard de Smet is general manager.

▶ The annual report of the United Verde Extension Mining Company, with mines at Jerome, states that the company produced 14,028,667 lb. of copper from U.V.X ore and 239,150 lb. from custom ore in 1936. The estimated few thousand tons of ore remaining in the mine will be removed and smelted at the near-by smelter of Phelps Dodge Corporation at United Verde. During 1936 the Clemenceau smelter made two runs, the last one concluding Jan. 12, 1937. The plant is being cleaned up of residues, flue dust, and furnace bottoms. The average cost per pound of copper produced during the year was 9.3c. The report states that by May or June future probable treasury requirements may be clear enough to declare a dividend.

▶ The old Bullwhacker mine, a former gold producer, situated 4 miles from Prescott, is to be reopened as soon as the weather permits by C. H. Reed, of Omaha, Neb., and a group of associates including George Krauff, of Prescott. A 25-ton mill is on the property. It is planned to deepen the shaft from 150 to 200 ft.

▶ A 10-ton Cottrell plant is being installed by F. C. Clark, of San Diego, Calif., on a quicksilver property in the Mazatzal Mountains, Gila County. The ore has been opened to a depth of 100 ft. H. Haueter, Box 27, Mesa, is in charge of operations.

▶ The International Vanadium Corporation is building a 100-ton mill on its property at Dripping Springs, near Globe. A new steel headframe is also being erected and extensive underground development is under way. More than 50 men are now employed by the company. H. A. Reed, of Globe, is president of the corporation.

▶ The new 125-ton flotation mill at the Vivian mine, 3 miles west of Oatman, recently commenced operations. The plant will treat the gold ores from the Vivian and Leland properties. Both properties are owned by the Vivian Mining Company. Arthur Dirrim is superintendent. T. V. Barton, of the Consolidated Chollar, Gould & Savage Mining Company, Kohl Building, San Francisco, is president of the Vivian company.

Tri-State

Zinc Mines Boosting Their Production

More properties to be opened and mills rehabilitated to increase stocks of concentrates—1,200-ton flotation mill of Evans-Wallower Lead Company destroyed by fire.

▶ The recent upward movement in zinc prices has started renewed activity in the Tri-State mining district. Commerce Mining & Royalty Company began operations at the Blue Goose No. 2 mill the middle of January. This mill had been idle since 1933. Installation of a new 10-in. Pomona turbine pump at the Paxson mine was completed the week of Feb. 20, and work of dewatering the mine started. This should require about six weeks, according to John A. Robinson, vice-president and general manager of the company. The Paxson mill was completed shortly before the depression of late 1929 and had been run only a short time. It is of modern construction and

is the only property in the district at which skips are still used to bring the ore to the surface. The 5-ton skips are hoisted in balance. The mill will be rehabilitated while the ground is being dewatered.

▶ The Evans-Wallower Lead Company's No. 4 mill was destroyed by fire on Feb. 8. The cause of the fire is not definitely known, but is thought to have started in an oil switch at the front of the mill. Though the night crew was working in the flotation mill, it did not discover the fire until it was too late to bring it under control. The mill had a capacity of 50 tons an hour and had been operated on a 24-hour basis, making it one of the largest producers in the field. According to F. S. Elfred, president of the company, a mill with half the original capacity will be constructed immediately and should be in operation early in May. The new mill will have a separate primary crushing unit and store the crushed ore in a 300-ton storage bin at the head of the mill. An eight-cell roughing jig with center feed will take the place of the usual two roughing jigs. The flotation unit will contain twelve Denver Sub-A cells. The building is designed so that the capacity can be increased by the addition of the necessary equipment to handle the increased tonnage.

▶ Charles A. Neal, president of the Mary M. Mining Company, announced the sale of his company to the Eagle-Picher Mining & Smelting Company on Jan. 26. The transaction was the largest consummated in the district in several years. No purchase price was disclosed, but the value of the Mary M. properties is estimated to be about $250,000.

▶ The production from the Central mill of the Eagle-Picher Mining & Smelting Company is being increased as the demand for concentrates rises. Mid-Continent Lead & Zinc Company has acquired the mining rights on the Bendelari mine of the Eagle-Picher Mining & Smelting Company in Kansas and is sending the ore to the Central mill. Underground work has been started at the Ohimo mine and at the Picher-Tulsa, formerly known as the Tulsa Lead & Zinc Company mine, by the Eagle-Picher Mining & Smelting Company. Ore from these properties will be sent to the Central mill.

▶ The tailings re-treatment mill of the Britt Milling Company has been reopened after a shutdown of more than a month, during which period the capacity of the mill was increased. It will now treat 100 tons of tailings per hour, according to Carl Britt, manager.

▶ Work has been started on reconditioning the Ritz mill of the Kansas Explorations, Inc., near Cardin, Okla. The mill should be ready to start about the first of March. It has been idle since April, 1931, and some work will be necessary on the mill shaft derrick before two American pumps capable of handling 1,500 gal. each can be installed for dewatering the mine. This mill had a capacity of 50 tons of crude ore per hour when last operated. Ross Blake is district manager for the Kansas Explorations, Inc., a subsidiary of the St. Joseph Lead Company.

Mexico

Engineers Study Mineral Deposits in Puebla

Railroad under construction in this State and Oaxaca expected to encourage exploitation—Company in Chihuahua requests permission to suspend operations.

▶ To further plans for exploitating important gold, silver, iron, and other deposits of the region by encouraging private initiative and organizing miners' cooperative societies, the Government has sent engineers to explore mineral wealth of the Mixteca zone, in the states of Puebla and Oaxaca. A railroad the Government is building from central Puebla to the Oaxaca west coast will traverse this zone, which is estimated to contain some 10,000,000 tons of high-grade iron ore.

▶ Contending the operations are unprofitable, Cia. Explotadora de la Mina Naica has asked Federal sanction to suspend work at its gold-silver-copper-lead property, Saucillo, Chihuahua, and to lay off 300 men.

▶ The Bank of Mexico will buy gold at the following rates: (3.60 pesos equal an American dollar): Placer gold, in impure bars, 3,860 pesos minimum per kilogram, exempt from deductions for any reason; 3,910 pesos per kilogram will be paid if the buying is done in Mexico City, and/or concentrates and precipitates 3,005 pesos per kilogram, less commissions and transportation, assaying, refining, and other costs.

▶ Gold valued at about $1,300,000 provided by mines in central Mexico was shipped to New York by rail during the last half of January. More shipping facilities are to be provided for the growing exports of base metals at Tampico in port improvements, including harbor dredging, breakwater construction, etc., for the accommodation of more and larger steamers. The federal Government is performing the work.

▶ Cia. Minera El Boleo, a French copper mining firm operating at Santa Rosalia, Lower California, has given its employees a general wage increase because of greater demand abroad at higher prices for its metal.

▶ American Smelting & Refining Company ended a labor conflict at its Aquiles Serdan unit, Chihuahua, by increasing minimum daily wages to 4 and 3.60 pesos for underground and surface workers, respectively, and allowing several other economic benefits, including a donation of 5,000 pesos (about $1,400) to help build a headquarters-recreation hall for the men. The pact was signed by P. B. Lord, El Paso, Tex.

▶ Record minimum daily wages for the Mexican mining industry of 5 pesos ($1.40) for underground workers and 4.40 pesos for surface labor were granted by Cia. Minera Metalurgica Maguarichic, operating gold-silver-lead deposits and a mill at Uruachic, Chihuahua. The company also allowed other liberal concessions, including full pay for help disabled by professional diseases and 60 per cent of wages for those laid up by non-professional ills.

▶ Cia. Fundidora de Acero y Hierro de Monterrey, Mexico's largest iron and steel work, which has its seat in Monterrey, Nuevo Leon, averted labor troubles recently by granting higher wages and most of the employees' demands.

▶ Experimental development of gold placers near Yiacui, Ixtlan district, Oaxaca, has been started by Cia. Minera San Carlos y Anexas, which has bought $28,000 of American machinery and hired 30 men for the undertaking.

▶ Production of 160 tons of ore daily is being averaged by Lane-Rincon Mines, Rincon Mina, State of Mexico. The ore contains gold and silver. Herbert E. Enos is manager.

Chile

Tailings From Braden Flumed 27 Miles

Mountainous country presented problems to disposal project—Mining activities in State indicate greater metal output

▶ The production of the Braden Copper Company at the beginning of the year 1936 was relatively low, in accordance with the quota set by the agreement among foreign copper producers, to which it subscribes. During the latter half of the year the output was rapidly increased to better than 80 per cent of present productive capacity. During February there was completed and put into operation a large new tailings-disposal project which had been under construction for the past three years. This job included the construction of some 27 miles of flume line over rough country to a natural basin having a capacity of approximately 300,000,000 tons of tailings, together with desanding equipment, overflow tunnel, and a complete townsite for several hundred people. At the smelter there was added a second reverberatory smelting furnace and a fourth large Peirce-Smith converter. During the year a considerable amount of new housing construction was carried on, including additional workmen's quarters, schools, a gymnasium, and other necessary structures.

▶ The index of mining production has had a steady increase since the middle of last year, showing an increase of 12.7 points in November over October, reaching 86.1. The rising production of copper is shown in the following monthly increases: September, 19,300 tons; October, 21,400 tons; and November, 27,100 tons. With the rate of production of foreign producers set at 105 per cent, copper production in the State is expected to show a substantial increase at the end of the first quarter of 1937. Gold production is also rising, along with that of silver and iron.

Lamaque Gold Mines Ltd., at Bourlamaque, Quebec, Canada, reported a successful year treating an average of 550 tons of ore daily in the company's 500-ton capacity cyanide plant shown above. The company, controlled by Teck-Hughes, increased ore reserves and is now speeding a major mine development program

Canada

Higher Metal Prices Raising Production

Smaller base-metal mines expected to be brought into operation during the year—New mill on west coast of Vancouver Island to cost $270,000

▶ The higher prices for copper, lead, and zinc that have prevailed in recent months, if sustained during the year, will result in the total value of those metals produced in British Columbia considerably exceeding the figures for the past six years. It is estimated that with the price of lead at its present level the value of its output in 1937 will exceed that of gold, thereby regaining the place of leadership among mineral products which it occupied from 1924 to 1932, except in 1928 and 1929, when it was displaced by copper.

▶ The Sullivan mine and Trail smelting plants of the Consolidated Mining & Smelting Company, Ltd., which is the largest producer of lead and zinc in British Columbia, and one of the largest in the world, are being operated at a rate approaching capacity, and as no immediate program of plant expansion is contemplated, the benefits of the higher metal prices will be reflected largely in increased earnings. There is a probability, however, if the prices are maintained, that a number of smaller lead and zinc mines in the Slocan, Ainsworth, and other areas will be reopened during the year. Plans are being considered for the reopening of the Lucky Jim, Noble Five, Slocan Rambler, Kootenay Florence, Utica, and Whitewater.

▶ The improvement in the price of copper has enabled an increase in the scale of operations of the Britannia Mining & Smelting Company almost to capacity. A bonus to employees of 25c. a shift was initiated Jan. 16. Sales of Howe Sound Company, the parent company, were 9,013,197 lb. in the final quarter of 1936, compared with 6,031,507 lb. in the preceding quarter. The Britannia at present is the only large copper producer in the Province, but it will be joined in the spring by the Copper Mountain mine and 2,500-ton concentrator of the Granby Consolidated Company at Allenby, which have been closed since 1930. A power plant is being constructed at Princeton to serve both mine and mill, and arrangements have been made to supply it with 200 tons of coal a day from a near-by mine. Steam turbines generating 2,500 kw. will be installed immediately for preliminary work, to be kept as a reserve unit later, when turbines generating 7,500 kw. will be installed for regular use. A. S. Baillie is general manager.

▶ The construction of the underground mill at the Big Missouri, Portland Canal district, is proceeding satisfactorily. The pilot tunnel, at the 2,150 level, has been completed to the mill chamber, 777 ft. from the portal, and the chamber itself is now being excavated. The power house is in the course of construction, although work on the penstock at the Long Lake dam has been discontinued until spring. Very encouraging results have been obtained in development of the 326 orebody at the 2,700 level, 115 ft. below the Province level. Work is under the direction of the Consolidated M.&S., which holds a controlling interest in the property.

▶ Abco Mines, Ltd., owning a large property on Herbert Arm, west coast of Vancouver Island, has concluded an unusual financial arrangement with British interests, which undertake to spend $270,000 in development and the construction of a 120-ton mill by April 1, 1938. In return, one-third of all profits will go to the British investors, the remainder being divided between Abco Mines and the Clayton-Walker interests, whose property adjoining the Abco is included in the deal. No provision is made, however, for the return of the capital investment and no stock will be delivered to the British people. Instead, one million unissued shares of the 3,000,000 authorized will be canceled. A. B. B. Henderson will direct operations on behalf of the investing group.

▶ Drainage of the gutter of Lighting Creek proceeded satisfactorily in January at the Wingdam "deep lead" operation of Consolidated Gold Alluvials, according to the general manager, D. Campbell Mackenzie. The level of water in the gutter for a distance of 250 ft. upstream from the raise was lowered from 16 to 7½ ft. during the month. A large quantity of water in the gutter for a distance of 1,000 ft. below the raise is being tapped by diamond-drill holes put up from the main drainage tunnel, driven in the bedrock 45 ft. beneath the gutter. Production from the interglacial deposit from Jan. 6 to the end of the month was 398 oz., valued at $12,338.

CANADIAN MINING INSTITUTE CONVENES

LEADERS of Canadian mining and men who played a notable part in bringing the industry to its present high position among the basic industries will gather at the Mount Royal Hotel, Montreal, on March 15, 16 and 17 for the 38th annual meeting of the Canadian Institute of Mining and Metallurgy. It is expected that about 800 delegates from all parts of Canada and the United States and from the leading mining plants of every province will attend. His Excellency the Governor General will address the delegates at the dinner on Wednesday night.

OTHER DISTINGUISHED GUESTS include the Hon. T. A. Crerar, Minister of Mines and Resources; the Hon. Maurice Duplessis, K.C., Prime Minister of Quebec; and the Hon. Onésime Gagnon, Minister of Mines for Quebec, all of whom will deliver addresses. The program will get exceptional attention in view of the great public interest in mining, and will cover all phases of the industry.

▶ Encouraging results have been obtained in extensive diamond drilling at Hedley Amalgamated, according to the secretary, Frank Parsons, of Vancouver. Thirty feet of core in No. 7 hole, from 370 to 400 ft., assayed 2.3 oz. gold per ton. P. W. Racey has been retained to correlate results and recommend on future development.

▶ Production of Sheep Creek Gold Mines in forthcoming months will be somewhat less than usual, until the shaft is deepened from the 10th to the 12th level and the east and west orebodies are opened at that depth. December output was $34,175, from 4,702 tons.

▶ About 100 tons of ore averaging about 0.3 oz. gold is being treated daily in the new flotation and cyanide plant at the Wesko, near Ymir, according to Arthur Lakes, consulting engineer. He expects the gross value of output will be about $30,000 a month and the operating profit $12,000 to $15,000. Reserves of reasonably assured ore are estimated at 72,045 tons, averaging 0.3 oz. gold, 2.16 oz. silver, and 2.7 per cent lead, and possible ore at 68,700 tons.

▶ January production at the Cariboo Gold Quartz, according to E. R. Rose, managing director, was 1,996 oz., valued at $69,856, from 6,512 tons of ore milled. A ball-mill clean-up late in the month yielded in addition 1,161 oz., of a value of $40,635. At the adjacent Island Mountain mine 3,558 tons was treated during January and 1,444 oz. produced, valued at $50,640. The value of output in 1936 is estimated at $630,474.

▶ Encouraging results are being obtained in development of No. 8 vein at Quesnelle Quartz, according to the president, Newton J. Ker, of Vancouver. A winze has been sunk on the vein from the 200-ft. level almost to the 400-ft. level. For the first 100 ft. the vein averaged 45 in. wide and carried an average of $17.74 in gold per ton. Ore was opened at the 300 level for a length of 107 ft.

Australia

New Shaft and Mill At Broken Hill

Ores will be treated by all-flotation method, producing a high lead concentrate — Boulder Perseverance, Ltd., to spend half a million dollars for equipping Enterprise Lease

▶ Zinc Corporation, Ltd., one of the three large companies operating at Broken Hill, New South Wales, is now producing lead concentrate assaying 77.3 per cent lead, 3.7 per cent zinc, and 20.8 oz. of silver per ton from ore assaying 16.4 per cent lead and 10.9 per cent zinc. This is the highest grade of concentrate ever produced on the field. The treatment rate is 30,000 tons monthly. Results from a pilot section in the main mill have established the fact that all-flotation is superior to gravity with flotation for the Zinc Corporation ore. A new shaft is being sunk and a new mill will be erected near by. It will have a capacity of 40,000 tons monthly. A. J. Keast, formerly of the Beattie mine, in Canada, is the superintendent.

▶ Boulder Perseverance, Ltd., recently acquired from Broken Hill Proprietary Company, Ltd., the Enterprise leases, at Kalgoorlie. To the 1,600 ft. level, development has proved 180,000 tons assaying 7.4 dwt. and indicated the existence of at least 450,000 tons. Boulder Perseverance, Ltd., is to spend £100,000 in equipping the Enterprise leases for 5,000 tons a month. The ore will be treated at the Kalgoorlie Ore Treatment Company's mill, which is to be extended to 27,000 tons monthly. Production is to begin early in 1938. Costs are estimated at 36s. per ton, and the profit at 20s. per ton. J. E. Manners, Box 79, Fimiston, W. A., is general manager.

▶ Mount Lyell Mining & Railway Company, Ltd., operating in Tasmania, milled 200,383 tons for the three months ended Dec. 31, 1936, for 13,216 tons of concentrates. This is the record mill. Production of blister copper was 2,856 tons, which is much lower than in previous quarters. Open-cut mining is now on a large scale, and a grade of ore less than 2 per cent copper is considered highly profitable. R. M. Murray is general manager.

MINES IN PORTUGAL GET MORE CAPITAL

BERALT TIN and Wolfram, Ltd., having mines in Portugal, announces that the British Metal Corporation has acquired options over 50,000 shares of its stock and exercised them at 7s. per share, which was slightly above the market. This gives Beralt Tin about £17,500 of new working capital. Its management has been taken over by British (Non-Ferrous) Mining Corporation.

▶ Wiluna Gold Mines, Ltd., Wiluna, W. A., treated 537,956 tons during the twelve months ended March 31, 1936, for a net profit of £439,894, compared with £411,857 for the previous period. A 10 per cent dividend absorbed £233,333. Operating results for the past two periods compare as follows:

	Year Ended March 31, *1935*	*1936*
Ore treated, dry tons	439,395	537,954
Av. gold value (gold 84s.)	27s.3d	24s.8d
Gold recovery, per cent	76.6	79.5
Fine oz. gold recovered	108,319	123,429
Value of yield (Aust.)	£941,167	£1,084,920
Working costs per short ton treated:		
Mining	9s.7.9d	10s.2.6d
Ore treatment	6s.10.2d	6s.5.3d
Bullion realization	2.7d	2.2d
General	4.4d	4.3d
Total	17s.1.2d	17s.2.4d

Ore reserves are estimated at 2,413,700 tons assaying 5.6 dwt., an increase of 373,000 tons, but a decline in grade of 0.6 dwt. The Wiluna orebodies are thought to be progressively poorer in depth. H. H. Carroll is general manager, T. B. Stevens, consulting metallurgist, H. E. Vail consulting engineer, and M. E. Playford chief metallurgist, of the company.

▶ An additional £130,000 is to be spent by Talbot Alluvials, Ltd., on the development of its deep lead properties at Talbot, Vic. Prospects are somewhat brighter, but it is doubtful if results will approach original estimates. Higher wages and lower output per man have increased costs much above the figure of 30 years ago. The higher price of gold is barely adequate to make wash containing 10 to 12 dwt. per square fathom profitable. J. W. Newberry is general manager and D. Lees is manager of mines.

▶ Golden Horse Shoe (New), Ltd., which was formed several years ago to carry on dump treatment at Kalgoorlie, treated 370,940 tons of tailing during the year ended Sept. 30, 1936. The profit was £13,167. The two Great Boulder dumps were recently acquired. One contains 1,900,000 tons assaying 1.65 dwt. and the other 1,202,000 tons assaying 1.0 dwt. The treatment plant is being extended to mill 60,000 tons monthly. J. E. Ede, Boulder, W. A., is general manager. T. B. Stevens is consulting metallurgist and Campbell Shaw is mill superintendent.

▶ Wattle Gully Gold Mines, N.L., Chewton, Vic., has paid its second dividend of 1s. per share. The new 20-head 1,000-lb. stamp battery has been placed in operation, and from mid-November to mid-January treated 3,405 tons for 1,890 oz., equivalent to 11.1 dwt. per ton. The shaft is 650 ft. deep. J. Tillis is mine manager.

▶ Gold Fields Australian Development Company, Ltd., which operates the Moonlight mine, at Wiluna, W. A., has exercised its option over the Kintore Mine, near Kunanalling, W. A. The company is also expected to exercise the option held over the Spargo's Reward Mine, at Spargos, in the same State.

▶ Norseman Gold Mines, N.L., Norseman, W. A., made a net profit of £70,400 for the twelve months ended Oct. 31, 1936. The mill treated 69,000 tons of ore and 44,400 tons of tailings for 21,420 fine ounces, valued at £188,123. The plant is now treating more than 7,000 tons monthly. Central Norseman Corporation, in the same district, is extending its milling plant to 6,000 tons' capacity monthly.

▶ Mount Isa Mines, Ltd., Mount Isa, Queensland, incurred a loss of £5,542 for the twelve months ended June 30, 1936. The plant milled 616,259 tons assaying 7.85 per cent lead, 11.1 per cent zinc, and 6.2 oz. silver per ton. The output of lead bullion was equivalent to 35,037 tons of lead and 2,794,707 oz. of silver. Costs, including smelting and realization, were unchanged at 22s. 7d. per ton milled. Ore reserves are 13,429,800 tons assaying 8.2 per cent lead, 5.4 oz. of silver, and 9.4 per cent zinc.

▶ The geophysical survey recently made of the Tennant Creek gold field by the Commonwealth Government has proved the existence of twenty anomalies. A bore on one of the indications assayed 4 dwt. per ton from 136 ft. to 176 ft. The field is located 300 miles north of Alice Springs and has always been handicapped by the disabilities of isolation and water shortage. Large hematite formations exist, in which the gold occurs.

Africa

Germans Open Copper Mine in Southwest Africa

Orebodies small but have high copper content—Increased monthly copper output expected from producers in Northern Rhodesia

▶ The German owners of Otavi Mines & Railway Company, Ltd., are making preparations for the company to resume productive operations. This mine, in Southwest Africa, has a good record as a producer of copper, lead, cadmium, and vanadium, the ores and concentrates always being shipped to Germany. It is not a big mine, but the ore is rich.

▶ Interim reports issued by the three Northern Rhodesia copper producers show that they together earned approximately $5,600,000, subject only to taxation, the last half of last year. Rhokana's production for the six months was 30,683 tons, Roan Antelope's presumably about the same amount, and Mufulira's (computed from gross revenue) approximately 15,957 tons, or a total of 77,323 long tons. Computing from these perhaps slightly inaccurate production figures, it appears that the final profit, after all deductions, averaged about £14 11s. per ton over a period when the price of standard copper in London averaged £40 18s. Roan Antelope's profit for the last quarter of 1936 was £307,000, against £174,500 for the September quarter; Mufulira's £99,500, against £70,000, though it was still producing at less than half of its capacity; and Rhokana's was £470,000 for the six months, reports of quarterly earnings not being published. It seems likely that Northern Rhodesia's copper production will be brought up to a rate of just over 200,000 long tons annually soon, as a further increase of 5,000 tons per month in the combined output of the three companies appears to be in sight.

▶ Though the search of Southern Rhodesia for gold deposits which can be worked on a large scale continues, no particularly favorable results are being reported. One considerable exploration undertaking has recently been abandoned, the average grade of the ore being found too low. Either grade or lack of continuity of the deposits threatens to bring disappointment to others. Nevertheless, the Cam & Motor and the Globe & Phoenix companies are continuing to develop considerable widths of good-grade ore at great depths.

▶ The 1936 gold production in Tanganyika Territory was valued at £489,796 which is a new high record, as it compares with £369,742 in 1935 and £295,690 in 1934. Of the total last year £337,731 came from the Lupa gold field, in which East African Goldfields is developing a promising property.

▶ Roan Antelope Copper Mines, Ltd., is retiring the entire issue, of £1,441,800 6 per cent debentures, at the redemption price of 107½ per cent. It has sold 420,000 shares of its treasury stock for £3 15s. per share, less 1s. per share commission, for which it will receive £1,554,000 net. The price offered was so near the market quotation that it was decided not to offer the stock to shareholders. When the debentures were issued, in June, 1930, the purchasers were given options on 750,000 shares at £2. The options expired without being exercised, and the company has now received £54,000 more than the 750,000 shares would have yielded, for 420,000 shares. Roan Antelope will now have only one class of stock and no debts.

A. Douglas Cullen

Copper smelting years ago by natives in Northern Rhodesia was done in crude mud smelters made of soil collected from anthills. Remains of the hard mud blowpipe rest against the side of this smelter.

South Africa

Miners' Silicosis Rate Reported Decreasing

Records kept for many years show downward trend of liability to contract disease—Anglo American Group forms new company

▶ Evidence of the remarkable decrease in the number of silicosis cases among working miners in South Africa who have been examined at the systematic periodical examinations of the Bureau is given in the latest report upon the work of the Miners Phthisis Medical Bureau. Figures quoted in the report show that the incidence rate of silicosis has fallen from 1.92 per cent in 1920-23 and 1.94 per cent in 1927-28 to 0.88 per cent in 1934-35. Compared with twelve or thirteen years ago, the general liability of the working miners as a whole to contract silicosis has in 1934-35 fallen by 64 per cent. Among the "New Rand Miners"—those who have entered the industry since August, 1916, and who have worked only on scheduled mines—the liability to contract silicosis was in the past year less by 90 per cent than in 1920-23. The "New Rand Miners" now constitute nearly 72 per cent of the total, but they contributed less than 12 per cent of the 193 new cases of developed silicosis.

▶ The Anglo-American Group during January floated a new £4,000,000 company called the "West Rand Investment Trust, Ltd." Sir Ernest Oppenheimer is the chairman. The new company is to take over from various Anglo-American Group finance companies their extensive holdings of certain gold-mining companies on Far West Rand. The entire interests in a large number of prospecting ventures located south and southwest of the Western Reefs discoveries which are being carried out under the aegis of the Anglo-American Corporation in the Free State and the Transvaal have also been taken over by the new company.

▶ According to the lastest available returns, the direct employment by the mines has increased from 24,000 white and 225,000 natives at the end of 1932 to over 37,000 whites and about 313,000 natives.

▶ A reason for lowering the grade of ore now mined on the Rand is the rise in the cost of production of an ounce of gold. In 1932, with a yield of 6½ dwt. per ton milled, the cost was roughly 59s. an ounce. The cost today, with a yield of less than 4½ dwt., is about 85s., which is equal to the price of gold in 1932. In working costs the industry is now spending about £3,800,000 a month, compared with £2,800,000 five years ago, and the working profit has risen from roughly a million and a quarter pounds to £2,700,000. Taxation at the same time has risen from 15 per cent to over 40 per cent, making the South African gold industry the most heavily taxed in the world.

▶ Several records were broken by the Witwatersrand gold industry during the past year. Milling reached the record figure of 48,610,620 tons, an increase of 4,112,570 tons over the record for 1935, and the average yield per ton declined from 4.728 dwt. to 4.568 dwt. In 1932 the average yield on a milling of 35,209,650 tons was 6.471 dwt. Working revenue in 1936 totaled £77,929,915, averaging 32s. a ton, also a record total, which compares with £74,790,876 (33s. 6d. a ton) in 1935 and £48,587,782 (27s. 6d. a ton) in 1932. Working costs were £45,775,622 (18s. 10d. a ton), also a record figure. The total in 1935 was £42,209,110 and in 1932 £33,876,218 (19s. 3d. a ton). Showing a decrease for the first time since 1933, the working profit last year was £32,054,293 (13s. 2d. a ton). In 1935 there was a record profit of £32,581,766. The 1932 total was £14,711,564 (8s. 4d. a ton). One of the most significant records of the boom year 1936 are the dividend distributions, which totaled £17,296,439, compared with the previous record of £16,437,264 in 1935 and with £8,993,294 in 1932.

PERSONAL ITEMS

F. R. Koeberlin, of Santiago, Chile, is in New York.

Ian Morley has resigned as manager of Mount Kasi Mines, Ltd., Yanawai, Fiji.

G. C. Lipsey has been appointed general superintendent of Chelan Copper Mining Company, at Lucerne, Wash.

H. Foster Bain arrived in Manila on Feb. 20 to become technical adviser on mining to the Philippine Government.

John Payne, Jr., formerly with Patiño Mines & Enterprises, in Bolivia, has gone to the Philippine Islands. His address is, care of Consolidated Mines, Manila.

Lucien Eaton has been in Nicaragua. It is expected that he will return to his home in Milton, Mass., about the middle of the month.

Frank N. Spencer has been elected a director of the New Jersey Zinc Company, succeeding Samuel Riker, deceased.

Glenn Anderson, mining engineer, of Los Angeles, is in San Salvador, C. A., on professional work for the Butters company.

Prof. C. S. Cullis has been chosen to be the next president of the Institution of Mining and Metallurgy (British). He succeeds **Robert Annan.**

Earle W. Bedford, consulting mining and metallurgical engineer, has established offices at 303 National City Bank Building, Manila, P. I.

Raymond V. Hurle has left Grass Valley, Calif., and is now on the staff of the engineering department of the Phelps Dodge Corporation at Ajo, Ariz.

A. M. McKilligan recently returned to London following examination of properties in the Gold Coast, Africa, for the North Ashanti Mining Company.

Byron G. Best, mining engineer with the Oliver Iron Mining Company on the Gogebic range, has been elected president of the Gogebic Range Engineers Club.

W. T. McCormick has been made director of safety of the iron mines of the Inland Steel Company. He will make his headquarters on the Marquette iron range.

Charles H. Kingsbury has accepted a position in the engineering department of the New York & Honduras Rosario Mining Company, of San Juancito, Honduras, C. A.

W. R. Lindsay has been appointed consulting engineer for Granby Consolidated Mining, Smelting & Power Company, Ltd., with offices in the Royal Bank Building, Vancouver, B. C.

J. B. Knaebel, mine manager of the East Mindanao Mining Company, in the Philippines, arrived in New York on the "Bremen" on Feb. 19, for several months' vacation, coming by way of the Continent and London.

W. Phoenix recently retired from the position of chief inspector of the Western Australian Department of Mines after 23 years' service.

Dr. Helmuth H. Schrenk has been appointed chief chemist of the health division of the United States Bureau of Mines. He succeeds **William P. Yant,** resigned. Dr. Schrenk is an alumnus (Ph.D.) of the University of Wisconsin. He was assistant State toxicologist of Wisconsin from 1923 to 1928, in which latter year he joined the staff of the health laboratory section of the Pittsburgh Experiment Station of the Bureau. Since September of last year Dr. Schrenk had been acting chief chemist of the health division, directing research in important dust-control investigations.

DR. HELMUTH H. SCHRENK

George E. Buchanan has become president of Virita Porcupine Gold Mines, Inc., and has also been added to the board of Porcupine Quartet Gold Syndicate, with holdings in the Porcupine district of Ontario.

W. R. Wade has opened offices as a consulting mining engineer at 315 Montgomery St., San Francisco, Calif. For a number of years Mr. Wade was associated with John Hays Hammond at 120 Broadway, New York City.

Major R. E. Franklin left London on Feb. 10 for the Gold Coast Colony, in West Africa, where he will be engaged for a few months on the examination of alluvial properties in Ashanti and the Gold Coast.

Robert E. Landon, consulting geologist and mining engineer, of Colorado Springs, Colo., has been appointed general manager of the American Eagle Properties, Inc., and the Western Leasing & Mining Company operations, both in Colorado.

Ralph Nevett, formerly research metallurgist of Zinc Corporation, Ltd., Broken Hill, New South Wales, is now on the metallurgical staff of New Occidental Gold Mine, N. L., Cobar, N. S. W.

S. E. Sullivan, formerly of Crosby, Minn., has opened an office in the First National Bank Building in Hibbing. It is understood that he will endeavor to pick up small ore leases and operate for independent interests.

M. M. Moser, formerly employed with the Braden Copper Company at Rancagua, Chili, was recently elected vice-president in charge of operations of the United Electric Coal Companies, 307 North Michigan Ave., Chicago, Ill.

W. B. MacPhee, who until recently had been mill superintendent with the New York & Honduras Rosario Mining Company for six and a half years, left Los Angeles on Jan. 28 last en route to the property of Cia. Aurifera Saramarca, via Lima, Peru, where he will be employed as mill superintendent.

R. M. Hix, who had been mill superintendent for the Cia. Minera de los Azules, at Santa Barbara, Chihuahua, Mexico, for the past year and a half, left on March 2 for Manila, P. I., to accept a position as mill superintendent for the Antomok Mining Company.

Evan Just has become secretary of the Tri-State Zinc and Lead Ore Producers Association, assuming the post made vacant by the retirement of M. D. Harbaugh on the latter's assumption of the vice-presidency of the Lake Superior Iron Ore Association. Mr. Just was graduated from the Northwestern University in 1922 and took the M. S. degree in geology at the University of Wisconsin in 1925. He has been an instructor in geology at Lehigh University and in 1927 and 1928 he was geologist in an expedition sent to Russia by the Aluminum Company of America to investigate bauxite deposits.

EVAN JUST

Worthen Bradley has been elected chairman of the San Francisco Section of the A.I.M.E., succeeding **Charles M. Romanowitz. Clyde M. Eye** was elected vice-chairman, with **Norman Wimmler** and **Robert Hawxhurst, Jr.,** as members of the executive committee, and **Herbert A. Swain,** secretary and treasurer.

E. C. Lansing has been appointed general superintendent of the Britannia Mining & Smelting Company, operating on Howe Sound, on the coast of British Columbia. **H. R. Taylor** has been made mill superintendent; **Kenneth Alexander,** power-plant superintendent; **N. E. Nelson,** consulting geologist; and **W. R. Landsay,** consulting mining engineer.

Charles H. Lindey, physical chemist; **Donald J. Reese,** foundry engineer; and **Frederick G. Sefing,** formerly assistant professor of metallurgy at Michigan State College, have joined the metallurgical staff of the International Nickel Company, Inc. **Richard F. Barnes, Jr.,** and **Carl Rolle** have also become associated with the company in consultive capacities.

D. M. Young has resigned from the staff of Marsman & Company and is now mill superintendent at the Ipo properties of the Benguet Consolidated Mining Company, operating in the Antamok Valley, Mountain Province district, in the Philippines.

George A. Morrison, who had for the past ten years been superintendent of mines and crushing for the West Penn Cement Company, of Butler, Pa., is now general manager of the Orogrande-Frisco Gold Mines, at Orogrande, Idaho, where a large, low-grade deposit is being developed.

George A. Kervin, manager of the Murchie, Zeibright, and Pennsylvania units of Empire Star Mines Company, Ltd., Grass Valley, Calif., is leaving for South Africa to become general manager of South African Copper Company, O'Okiep, Namaqualand. He is succeeded by **Robert Hendricks,** formerly superintendent at the North Empire mine, Empire, Ontario, Canada. Mr. Hendricks' position at Empire was filled by **Arthur Kendall,** until recently superintendent at the North Star mine at Grass Valley. **M. E. Newlove** succeeds Mr. Kendall.

Robert Murray, superintendent of the Scranton mine, on the Mesabi, for Pickands Mather, has retired after forty years in the mining business. A banquet was held in his honor at Hibbing, Minn., by employees of Pickands Mather & Company and his associates on Feb. 13.

E. J. Fearing, superintendent of the Sagamore mine, at Ironton, Minn., has been transferred to the Scranton mine, at Hibbing, Minn., to replace Mr. Murray, retired. **P. S. Gray,** of Bovey, Minn., will take charge of the Sagamore mine. Mr. Gray at one time was in charge of the Dunwoody mine, at Chisholm, Minn.

Wendell W. Fertig, formerly chief engineer and geologist with Baguio Gold Mining Company, is now employed as consulting engineer with Dulangan Mining Interests, Inc., and Golden Gate Mining Association. The two companies own numerous properties in various parts of the Philippines. Mr. Fertig also maintains an office as consulting engineer at 602 Heacock Building, Manila. He was associated in the United States with Nevada Consolidated Copper and Shenandoah-Dives Mining.

C. E. MacQuigg, for many years research metallurgist with Union Carbide and Carbon Research Laboratories, has been named Dean of Engineering of Ohio State University. Mr. MacQuigg, who is at present in Europe on corporation business, will assume his new duties at Columbus about July 1. In his new capacity he will also be ex-officio director of the Engineering Experiment Station of the University and, in effect, chief of the research work to be done under the newly organized Ohio Engineering Research Foundation. This organization has been set up to facilitate cooperation between the industries of the State and the University in the conducting of research and the maintenance of research fellowships in Columbus.

Dr. Waldeman Lindgren, of Brighton, Mass., professor emeritus and former head of the geology department of Massachusetts Institute of Technology, was on Feb. 19 awarded the Wollaston Medal for mineralogical research, by the Geological Society of London.

OBITUARY

Sir Albert Kitson, geologist, died in Baconsfield, England, on March 8 at the age of 69.

Richard V. Ageton, an authority on potash and deputy mining engineer of the United States Geological Survey, died in Albuquerque, N. M. on March 2 at the age of 50.

Raymond Jorgensen, Sr., for many years dredge master for the Natomas Company, died recently at Natoma, Calif., aged 55.

D. F. Meiklejohn, well-known Nevada mining engineer, died recently in Los Angeles. He was a graduate of Stanford University, and at the time of his death was president of the Old Stone Cabin Mining Company.

George W. Riggs, long recognized as an authority on mine safety engineering, died on Jan. 28 at Uniontown, Pa. Last year Mr. Riggs served as president of the National Mine Rescue Association and he had previously been a member of the Safety Division of the United States Bureau of Mines.

Edward Herbert Cook, mining engineer, of Culiacan, Mexico, died in Los Angeles on Jan. 21 of this year. He was born on June 26, 1861, and was graduated from the University of Alabama in 1884. Going to Arizona, he became associated with Dr. James Douglas, of the Phelps Dodge Company, in the development of properties in Arizona. In 1901 he became field engineer for the Kansas City Smelting & Refining Company, later taken over by American Smelting & Refining. He had had extensive experience in Mexico also. Mr. Cook had long been a member of the A.I.M.E.

Horace F. Carpenter, mineralogist, who had been in the business of refining gold and silver since 1860, and who discovered the process of extracting gold and silver from photographic waste, as well as a method for producing pure gold for commercial purposes, died on Feb. 28 in Providence, R. I., in his 95th year.

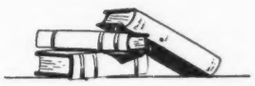
Mark L. Requa, mining engineer, civic leader, and a leading Republican of California, which State he represented on the Republican National Committee, died in Los Angeles on March 6 at the age of 70. He was assistant to Herbert Hoover when the latter was Food Administrator during the War, and a vice-president of the A.I.M.E. from 1917 to 1920.

Arthur Wilton Jenks, mining engineer and metallurgist, died on Jan. 28 last at San Jose, Calif. He was graduated from the School of Mines, Columbia University in 1886, and had a widely varied professional career in this country and abroad. His first important engagement was with the Aurora Smelting & Refining Company, at Aurora, Ill., as assistant superintendent. In 1888, with Eben E. Olcott, former president of the A.I.M.E., he took part in an investigation of the alluvial gold deposits of Dutch Guiana. Among his other activities he served as superintendent of the Balbach Smelting & Refining Company, Newark, N. J.; of the Backus & Johnston smelter, at Casapalca, Peru; and of the Cia. Minera de Peñoles, Durango, Mexico. He was later resident manager of the mines and smelter of the Famatina Copper Company, Chilecito, Argentina, and of the smelter and refinery of the Burma Corporation, Namtu, Burma, at the time when Herbert Hoover was largely interested in that property. During a number of years, also, he made mine examinations for investing clients in the United States and abroad.

Measuring Distance Between Lines of Sight of Main and Auxiliary Telescopes

THROUGH an unintentional oversight we omitted the name of the author of this article published in our issue for November, 1936. The manuscript was submitted by H. F. McFarland, Morococha Mines, Cerro de Pasco Copper Corporation, Peru. In making this acknowledgment we also correct an obvious typographical error called to our attention by T. G. Murdock, Minas de Matahambre, Matahambre, Cuba. In the fourth line from the end of the article the abbreviation for "seconds" was interpreted to read "inches." The corrected sentence would read "the angular error . . . should not be more than 30 sec." EDITOR

NEW BOOKS



PAY STREAK. *By John Baragwanath. Doubleday, Doran & Company, Inc., Garden City, N. Y. Pp. 274. Price $2.*

OUT OF THE SOUTHWEST. *By S. W. Traylor, Sr. Published by the author, Allentown, Pa. Pp. 255. Price $2.*

IT HAS often been remarked that the adventure and romance associated with mining afford the finest material for literature in which truth is stranger than fiction. Such was the substance of John Hays Hammond's autobiography, which seems to have inaugurated a flow of personal stories and reminiscences of which the two books by Baragwanath and Traylor are recent examples. True to the mining tradition, the experiences of these engineers sparkle with adventure at home and abroad.

Mr. Baragwanath's book portrays a lively series of dramatic incidents, the stage for most of which was set in Peru, Mexico, and other Latin American countries, although his experiences in the United States were not without their tense moments. Nor do any of the tales lose glamour in the author's telling. His informal and easy style of narrative holds the reader's interest to the climax of one incident, and launches him into the next with pleasant expectancy. Tales of lost mines, buried treasure, poker games, romance, native superstition, "salting," and Latin American revolutions pass in review like a series of Arabian Nights stories, with a glamorous thread of adventure running throughout. The book is in no sense a complete autobiography. It merely records the early and adventurous part of the author's life, in which mining engineers particularly will find a fascinating interest.

Mr. Traylor's story of "A Texas Boy" covers the period from his humble birth in 1869 to the present, and records his rise to prominence as an engineer and manufacturer of mining machinery. Here is the kind of story in which Americans take pride, because it reveals the struggle from poverty to affluence through which the author won his way by hard work and merit. Mechanical aptitude marked his early years and led him consecutively from one job to another, in which he perfected his practical knowledge of men and machines. Like many another member of the mining fraternity, Mr. Traylor's first introduction to the industry was via the Guggenheim interests, at a smelter in Mexico. And it was through a member of that family that he was induced to supplement his practical experience with college training. Then followed years of experience as a salesman for the Colorado Iron Works Company, in which he laid the foundation of acquaintance and experience for the later establishment of the Traylor Engineering & Manufacturing Company. Mr. Traylor was intimately familiar as an engineer with many mining promotions, some of which were famous fiascos and others equally well-known successes. Hence the interests in his inside stories of Weaverville, Arizona Consolidated, Nevada Consolidated, and many lesser properties. The author concludes his biography with a record of the service rendered by his company and himself during the World War. The whole story is marked by personal initiative and integrity, and will be read with much satisfaction.

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PROSPECTING AND OPERATING SMALL GOLD PLACERS. *By William F. Boericke. John Wiley & Sons, Inc., New York. Second edition. Flexible cover. Pp. 144. Illustrated. Price $1.50.*

PUBLICATION of the second edition of this book is at once a tribute to the timeliness and excellence of the first edition and an evidence of popular interest in the subject. The principal change in the revision consists in rewriting the chapter on placer mining machines, in which the author selects for description those of demonstrated merit. The rise in the price of gold to $35 per ounce has necessitated a revision of many statements in the first edition as to the value of gravel and gold particles.

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HANDBUCH DER GEOPHYSIK, BAND I, LIEFERUNG 4. *W. Heiskanen: Beobachtung der Schwerkraft (Gravity Observations); Die Lotabweichungen (Deflections of the vertical); and Das Problem der Isostasie (The problem of isostasy). Berlin, Verlag Gebr. Borntraeger, 239 pp. plus XV, 83 fig.*

THIS is the fourth and concluding installment of the first volume of the Manual of Geophysics, edited by Professor Gutenberg in Pasadena. The first volume deals with the earth as a planet. The present installment, in its first part, connects with the topics covered in the last section of the preceding installment and discusses first various methods of gravity observation. The theory of the pendulum is derived and pendulum measurements are discussed, with special reference to corrections, absolute and relative gravity determinations, marine gravity observations, and static gravimeters. The various reduction methods of gravity observations, such as the free air, the topographic and isostatic reduction, are derived and described in detail, with some reference to discussions in recent literature about their physical and geological significance and justification. The section is concluded with a description of torsion balance measurements, including the determination of vertical gravity gradient.

In the next section a detailed discussion of geodetic measurements for the determination of plumb line deviation, and the geodetic and geologic significance of the results, is presented. The concluding section of the book deals with isostasy and its methods, and presents a discussion of major gravity anomalies in various parts of the world.

The information on gravity measurements and results is well presented, concise, and definite. As is unavoidable in a cooperative scheme where various authors work on overlapping subjects, there is some duplication in the discussion of certain methods of gravity measurements; for instance, the Bifilar Gravimeter is treated in this volume and in the section on bodily tides, and there might be some question as to whether the discussion of static gravimeters and torsion balance observations might not have been shortened in this volume in favor of a more detailed treatment in the volume devoted to geophysical prospecting. However, this is a rather unimportant criticism and not intended to detract from the value of this volume.

C. A. HEILAND

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PAY DIRT—*A Panorama of American Gold Rushes. By Glenn Chesney Quiett. D. Appleton-Century Company. New York. Pp. 506, with 86 illustrations and 9 maps. Price $4.50.*

HERE is a fast-moving, flowing account of the search for gold. It gives the reader a clear picture of American rushes, from the early days in the Western states, to Alaska, and to the present-day mines in northern Canada. Of particular interest are the accounts of the historic characters who played their parts and passed on. Humor abounds.

Many anecdotes are told of lucky strikes, lost mines, ghost towns, the tough mining camps—with their eccentric and notorious characters. Tall stories of bad men, wild women, gamblers, and road agents are picturesquely related. But the more important things are not neglected. Figures are given and the development of the great mining areas is followed from the time of the Rocky Mountain canary and the slow-moving covered wagon to the modern fast transit by airplane. The book is well illustrated with carefully chosen pictures.

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ECONOMIC GEOLOGY OF MINERAL DEPOSITS. *By Ernest R. Lilley. Henry Holt & Company, New York. Pp. 811; illustrations, 301. Price $5.*

AS STATED in the preface of this new book, the author has intended to stress the relation between the geologic factors and the economic value of mineral deposits. In this he has succeeded admirably, and any work that brings these factors together into a single volume is to be commended. The economic and political factors involved in the occurrence and distribution of mineral products and their relations to the world's commerce are discussed

under each of the mineral products taken up. An additional feature of value is the discussion of technical considerations in the working and treatment of mineral products.

The remainder of the book, however, must be classed as a descriptive account of mineral deposits similar to a number of elementary texts that are already available. Although the first 90 pages are classified under the heading of "General Principles" involved in the formation of mineral deposits, one looks in vain for factual data and discussion of principles and processes by which mineral deposits are formed, without which the serious student of economic geology eventually finds himself badly handicapped. The important influence of geologic structures on the formation and localization of mineral deposits appears to have been entirely omitted. Likewise, any reference to the use of the microscope in the study of mineral deposits.

The book is well illustrated with a large number of fine maps, sections, and diagrams chosen from the literature on economic geology. Its subject matter is arranged largely according to the use to which mineral products are put, and each section contains a selected bibliography. The volume will serve as well as others as a text for students beginning the study of geology.

PHILIP KRIEGER

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LA GEOLOGIE ET LES MINES DES VIEILLES PLATEFORMES. *By F. Blondel, Ingénieur en chef des Mines, Publications du Bureau d'Etudes Geologiques et Minières Coloniales, Paris, France, 1936. Pp. 303.*

ACCORDING to the author, the purpose of this book is to direct and facilitate geologic exploration and mining in the French colonial possessions. It represents the substance of a series of lectures given at the Museum of Natural History, Paris, in 1934-35, and is primarily intended for use by those who lack specialized geologic training. It should be particularly helpful to those who are not adept in reading the French language.

The first part of the book deals largely with general and regional geology. Its object is to acquaint the reader with the most prominent and significant features of geologic history and the areal distribution of rock strata in the continental and more important island areas of the world. The characteristics of the old platforms or shield areas are set forth, together with explanations of the meaning of the shield concept in geology and its practical significance.

The second part of the work opens with a discussion of the main features of metallogenic provinces and their meaning and significance in relation to mineral exploration. This is followed by brief but good descriptions of the general geology, character of ore, and production data for specific mines. These examples were chosen from various parts of the world to illustrate the fundamental similarities and differences in the various types of mineralization and their relation to the shield areas. All of the commercially important metallic and non-metallic substances are included. Numerous geologic maps, drawings and graphs are used to supplement the text. A simple French prose style with minimum of technical geologic terms should materially increase the value of this book, which was written by a French mining geologist of wide experience.

WILLIAM H. IRWIN

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MECHANICAL POWER TRANSMISSION HANDBOOK. *By William Staniar, McGraw-Hill Book Company, New York. Pp. 488. Price $5.*

TO REVIEW Mr. Staniar's recent work was a real pleasure. The thoroughness with which the author has covered this important subject is more than refreshing. In no other single volume has mechanical power transmission been explained and represented so clearly and interestingly. The book's outstanding feature is the fact that it embraces within its covers exactly the data needed by plant superintendents, plant maintenance and industrial engineers, mechanical designers, draftsmen, master mechanics, sales engineers, and students of proper selection and application of mechanical power-transmission equipment, and omits to a great extent the introductory and elemental material found in the average handbook.

Engineers and those responsible for plant maintenance at factories, mines, and smelters will find the wealth of information and advice contained in the work most helpful. Arrangement of the material and typography are exemplary. Problems, charts, and formulas are presented simply, which makes the volume attractive and valuable also to men of limited technical training. The author is to be congratulated for the careful, painstaking labor which must have been necessary in the compilation and assembly of all data contained in the volume.

JOHN B. HUTTL

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RUTLEY'S ELEMENTS OF MINERALOGY. *By H. H. Read, Twenty-third edition, revised and enlarged. Thomas Murphy & Company, London, England. Pp. 498. Price 8s.*

A MINERALOGY which has gone through twenty-three editions, with numerous revisions, is worthy of special consideration. In the twenty-third edition, the descriptions of minerals have been brought up to date and even the most recent changes suggested by the committee on nomenclature of the British Mineralogical Society and the Mineralogical Society of America have been adopted. In spite of careful revision and the addition of a considerable amount of new material, the book has not gone beyond the stage of usefulness for students first taking up the study of the subject treated.

In many respects the classification of minerals according to the related elements of the periodic table is useful, although, as in the case of all classifications, it leads to certain difficulties. To those familiar with the classification of Dana, many of the mineral descriptions will appear out of place. On the other hand, the economic grouping of the minerals, such as the copper minerals, the silver minerals, and the iron minerals, has decided advantages from the standpoint of elementary instruction.

The description of the optical properties of minerals will be found useful for the beginner, and the simplified discussion of crystallography from the geometrical standpoint is to be commended. The illustrations are entirely line drawings, and no attempt has been made to reproduce photographs.

On the whole, the twenty-third edition of "Rutley's Elements of Mineralogy" will be found useful for students starting the subject, and will serve as a guide for those who desire an introductory discussion which is at the same time thoroughly up to date.

PAUL F. KERR

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BIG BUSINESS: ITS GROWTH AND PLACE. *Prepared under the auspices of the Corporation Survey Committee of the Twentieth Century Fund, Inc., New York, N.Y. Pp. 102. Price $1.35.*

THIS is the first of three volumes embodying the results of a study of big corporations, and their place in American life, which was begun in August, 1934, by a special research staff. Two succeeding volumes will be entitled How Profitable is Big Business? and Big Business Salaries. This first volume attempts to show how large big business bulks in comparison with the smaller concerns on the American economic map as a whole, and on the various sectors of the map which represent specific industries and groups of industries. The report is purely factual. After all three studies are published, a special committee will formulate a plan of action to meet whatever problems the research reveals.

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PUBLICATIONS

RECEIVED

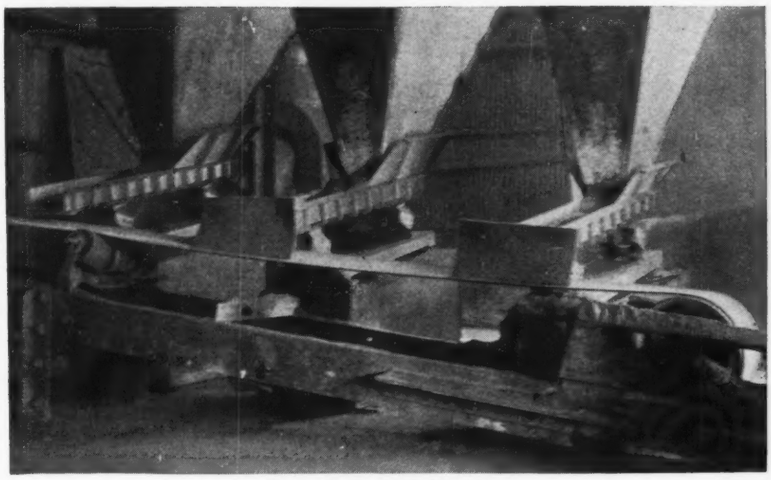
✦ *The Future of Canadian Mining.* A Series of Twelve Radio Addresses Broadcast in Canada, Jan. 31-April 24, 1936. By the Hon. T. A. Crerar, Minister of Mines, Ottawa. Pp. 83. Price 25c.

✦ *Silicosis and Allied Disorders.* A report of the Medical Committee of the Air Hygiene Foundation of America, 4,400 Fifth Ave., Pittsburgh, Pa. A program for protecting health of industrial workers and a plan of medical research to curb industrial diseases. A summary of this report is available to the public.

✦ *Aerial, Geological and Geophysical Survey of Northern Australia.* Report for periods ended June 30, 1935, and Dec. 31, 1935. Published by L. F. Johnston, Commonwealth Government Printer, Canberra, Australia. Pp. 86, with numerous maps and aerial photographs. Price 4s. 3d.

✦ *Bibliography of the Geology of Newfoundland.* 1818-1936. By Rachel M. Betts, Princeton University, Bulletin No. S, Department of Natural Resources, St. Johns, Newfoundland. Pp. 35.

EQUIPMENT NEWS



New Vibrating Feeder

THE SYNTRON COMPANY, of 510 North Lexington Ave., Pittsburgh, Pa., has announced a new model of vibrating feeder conveyor. The unit consists of a conveying trough, either of the flat, open type or a circular tubular type, reciprocated at high speed through a very short movement, by powerful, pulsating electro-magnets. Bulk material flows through the trough at a speed in direct proportion to the amplitude of vibration, which is controlled electrically through a rheostat in a separate control panel which has been arranged for wall mounting.

The manufacturer points out the advantage of the electric control of volume flow, which can be varied from a slow dribble to the maximum capacity of 50 tons per hour. The feeder will handle dry or moist bulk materials equally well in either a horizontal or down-grade position and is said to be efficient for controlling the feed of material to dryers, mixers, weigh hoppers, or belt conveyors. The equipment is said to use little power, and it operates on a 110 volt, single-phase ordinary lighting current.

Heat-Indicating Paint

A PAINT that changes color when exposed to heat is announced by the Efkalin Company, of 804 East 141st St., New York City. The paints are of two types: one will turn back to its original color after cooling and the other will remain permanently changed. Of the first type the manufacturer lists seven colors that will change in a temperature range from 104 F. to 464 F. and of the permanently changed types, five will discolor in temperatures ranging from 300 F. to 734 F. It is said that each of the color changes is sharp and wide, leaving no doubt as to the heat of the object to which the paint is applied. The permanent-change type of paint requires recoating after each change, but the retroactive ones are good for from 25 to 50 changes. The paints are said to be so scientifically compounded and controlled that they do not deteriorate in the package and, if stored according to directions, will keep twelve months. The manufacturer lists the following applications for the Efkalin heat-indicating paint: on all visible machine parts subjected to friction, and machine parts requiring lubrication, on equipment carrying electric current, or material that may be destroyed by overheating.

Motor Control on Welders

A NEW DEVELOPMENT in arc welding announced by the Hobart Brothers Company, Troy, Ohio, manufacturers of Hobart "Simplified" Arc Welders, embodies what is termed as "Selective Motor HP Control." It is said that this is the first arc welding set equipped with economical control of the motor as well as the generator. The manufacturers' announcement claims that the results are (1) Welding current costs are cut in average work, (2) Power company penalties due to poor power factor of equipment are avoided, (3) Expensive rewiring of many plants is eliminated, and (4) Idling and light load power losses are cut in half.

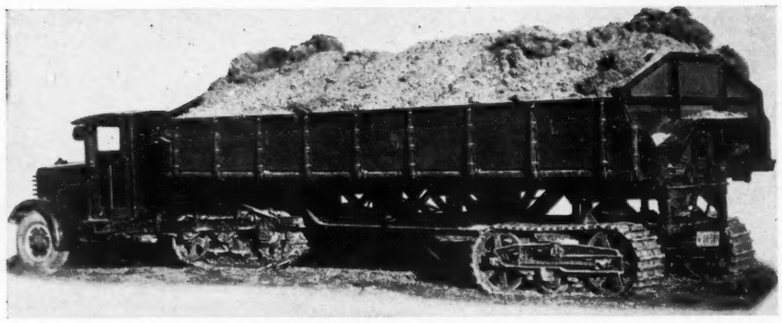
When it is desired to operate at higher rates, a convenient lever releases the handle for turning easily to the "high" position, where the full rated horsepower of the motor is available for full load and overload welding. At the same time it is possible, when so desired, to start and weld in the "high" position without turning the handle to the "low" setting at any time. The new Series MN Current Saving Models are available in 75 amp., 1½ to 3 hp.; 100 amp., 2½ to 5 hp.; 15 amp., 5 to 10 hp.; 200 amp., 7½ to 15 hp.; 300 amp., 10 to 20 hp.; 400 amp., 12½ to 25 hp.; and 600 amp., 20 to 40 hp.

For Mounting Maps

A SUBSTANCE known as Parafilin, manufactured by the Menasha Products Company, of Menasha, Wis., is used as a mounting adhesive for geology, topographic, or other types of maps. The substance comes in rolls, and is said to produce a waterproof seal when hot-pressed between pieces of paper, cloth,

metal, glass, wood, and other similar material as a mounting background. The manufacturer states that it eliminates the time necessary to wet the background and the article to be mounted, spread paste, smooth and press the sheet, and allow drying time, and it removes the chances of distortion and damage to colored drawings and maps.

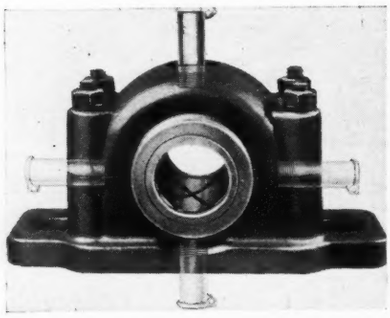
A PIPE JOINT CLAMP made by M. B. Skinner Company, 3720 West Sample St., South Bend, Ind., is said to stop any thread leak at joints where pipe is screwed into fitting . . . under pressure . . . without shutdown



COMBINATION TRACTOR TRAILER with a body capacity of 25 to 30 yd. is offered for contracting, mine stripping, and other haulage jobs where huge capacities are essential, by the Linn Manufacturing Corporation, of Morris, N. Y. Model 37-T, shown above, employs the standard Linn tractor chassis, with specially designed trailer unit

Universal Pillow Block

BECAUSE it is often impossible to know in advance of a machine installation how the pillow blocks will have to be mounted, the Randall Graphite Products Corporation, 609-613 West Lake St., Chicago, have developed a "Universal-type Double Reservoir Oil Return" pillow block, which the manufacturer says



can be mounted in any position, according to the requirements of each individual installation. With this Universal pillow block, it is necessary only to select the mounting position needed, unscrew the oil cup, turn the ball to this position, and reinsert the oil cup vertically. This type of pillow block has two large reservoirs in the spherical ball. A supply of oil is placed in the upper one which feeds the shaft as needed through graphite feed plugs and graphite pressure-packed channels. Oil recovery grooves divert unconsumed oil into the lower wool-packed reservoir. This oil is again fed to the shaft and bearing through lower graphite feed plugs. This type of pillow block is said to hold almost three times as much oil as the standard type and will therefore operate for much longer periods on a single oiling.

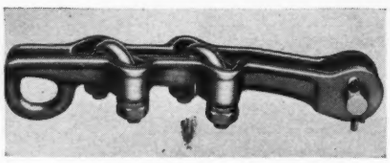
Oil Circuit Breakers

A NEW LINE of 15,000-volt oil circuit breakers, utilizing the oil-blast principle and incorporating a simpler operating mechanism, simpler internal mechanism, and fewer bearing points, has been announced by the General Electric Company. The new breakers are identified as Types FLO-1A, FLO-1B, and FLO-1C. Interrupting ratings are 50,000-, 100,000-, and 175,000-kva. respectively. The new breaker has a horizontal break with the three poles in a single rectangular steel tank. Oil blast ports provide an extremely rapid extinction of the arc with little burning of the heavy arcing contacts. A horizontal oil baffle divides the tank into two parts interconnected by three ports, one opposite each pair of contacts.

The main contacts are of the heavy wedge and finger type, with silver-to-silver contact surfaces. The stationary fingers are said to be pivoted so that they are self-aligning with the wedge-shaped copper blades which are securely attached to the horizontal contact carrier. The FLO-1A breakers have heavy butt-type arcing contacts; finger-type arcing contacts with large tips are used in the FLO-1B and FLO-1C breakers. The arcing contacts of the FLO-1C breakers, which are subject to heavier currents than the others, are surfaced with an arc-resisting alloy having several times the life of copper.

Straight-Line Clamp

TO PROVIDE a suitable straight-line clamp for station dead-ending or for line use where the engineer prefers a holding device of this type, the Ohio Brass Company, of Mansfield, Ohio, has developed a clamp known as the Strateline. Used



in either line or station, this clamp is easy to install. It is light in weight, but is said to develop slip strengths of 50 per cent of the ultimate strength of hard-drawn copper conductors.

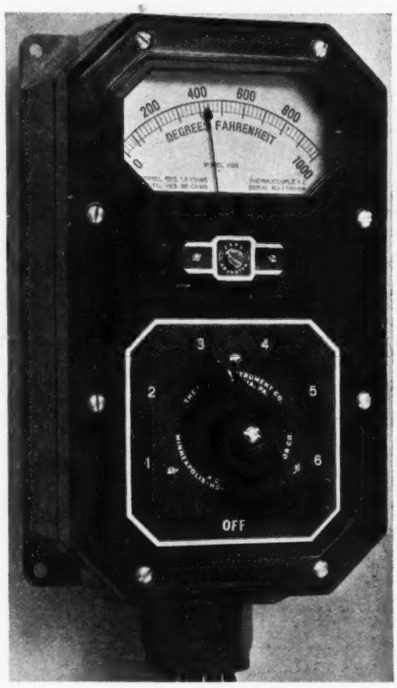
Where stations are designed with the use of cables for buses, this clamp is said to give a straight-line job with no chance for wire or clamp to twist. Intermediate fittings are not necessary when dead-ending cable buses, as the clamp connects directly to a clevis-type suspension insulator. When used to dead-end conductors or transmission structures, the companion fittings, either the long socket eye or clevis, are said to provide clearances for the conductor. The eye at the end of the clamp makes hot-line changes easier and safer.

This type of clamp is available in three sizes: for cable diameters of 0.28 to 0.43 in., 0.42 to 0.55 in., and 0.54 to 0.68 in., and it can be furnished with a socket eye, a clevis, or with no fitting.

Diesel Engine Pyrometer

A NEW PYROMETER, designed especially for diesel engine service, has been announced by the Brown Instrument Company, Philadelphia, Pa. It is available in three temperature ranges from 0 to 1,000 deg. F.; 0 to 1,200 deg. F.; and 0 to 1,600 deg. F., and with the following combinations of switch points: 4, 6, 8, 12, 16, or 24. The 0-1,000 deg. F. range instrument is also available with "cold," "normal," and "danger" operating zones plainly indicated on the scale.

Great vibration-resisting quality is said to have been built into the Brown diesel engine pyrometer by designing it for extreme ruggedness and light weight. The measuring system is said to be highly sensitive in all standard ranges. It is provided with a special neutralizer



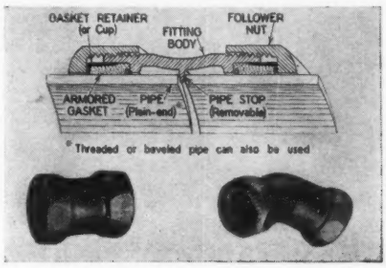
having a negative temperature coefficient, thus permitting the use of heavy springs in the system while still maintaining a low over-all temperature coefficient.

A dial-type switch, integral with the pyrometer, is mounted in a separate compartment of the pyrometer case, enabling an operator to select temperature indications with the utmost convenience from any number of thermocouples in combinations mentioned in the foregoing. Leads, 20 in. long, are brought from the switch points through a pipe fitting in the bottom of the box. This construction permits use of a junction box at a remote point where vibration is non-existent or less severe than at the instruments.

Each pyrometer is said to be calibrated within 1 per cent of full range in the normal operating zone and within 2 per cent outside that zone.

Fittings Eliminate Pipe Threading

S. R. DRESSER Manufacturing Company, 421 Fisher Ave., Bradford, Pa. announces a standard line of self-contained pipe joints that are said to make tight, flexible connections on plain-end or threaded pipe. These fittings, accord-



ing to the manufacturer, eliminate time for cutting pipe to exact lengths, threading, grooving, or screwing up joints in cramped quarters.

After inserting the plain-end pipe into the fitting (which comes completely assembled), it is only necessary to tighten two threaded octagonal follower nuts (see cut) with a few quick turns of the wrench. As this is done, resilient "armored" gaskets at each end of the fitting are said to be compressed tightly around the pipe, forming a positive seal. The resulting joint, Dresser engineers point out, is not only permanently tight but absorbs normal vibration, expansion, and contraction movement, and permits deflections of the pipe in the joint. If the pipe is already threaded, it can also be joined in the same way.

The complete line of Style 65 fittings includes: standard and extra-long couplings, ells both 45 deg. and 90 deg., and tees, all supplied in standard steel pipe sizes from ½ in. I.D. to 2 in. I.D., inclusive, black or galvanized. These fittings are recommended by the manufacturer for simplifying joint-making and repair work on both inside and outside piping, for oil, gas, water, air, or other industrial lines.

INDUSTRIAL NOTES

The James F. Lincoln Arc Welding Foundation was recently established by vote of the Lincoln Electric Company's directors, of Cleveland, Ohio, in honor of the pioneer work of the company's president in promoting arc welding and in perfecting and developing arc-welding equipment and electrodes. The foundation is dedicated to encouragement of study and research for benefit of the arc-welding industry, and one of its primary functions will be the stimulation of original design in order that arc-welding processes may be more widely utilized in modern-day fabrication. Principal direction of the Foundation's work will be given by Dr. E. E. Dreese, head of the department of electrical engineering at Ohio State University. Other trustees who will serve with Dr. Dreese on the Foundation are W. B. Stewart, member of the Cleveland bar; and H. R. Harris, vice-president of the Central National Bank of Cleveland. Commenting on the honor bestowed upon him, President James F. Lincoln said in part: "In laboratory, and in mill and factory the world around, scientists and technicians are seeking to develop new phases of the electric arc as a superior welding technic. The sole purpose of our new Foundation is to stimulate the ingenuity of scientists, engineers, and skilled workers interested in extending the frontiers of knowledge and achievement. This arousing of interest will result, I believe, in lower production costs for thousands of devices and commodities now employed in manufacture or moving in commerce; and I feel signally honored in having my name attached to a movement which seeks to give constantly increasing markets the benefit of better, stronger, and more serviceable goods." A substantial cash-prize competition has been announced by the Foundation for papers dealing with arc welding as a primary process of manufacture, fabrication, or construction of industrial equipment. For particulars write The James F. Lincoln Arc Welding Foundation, P. O. Box 5728, Cleveland, Ohio.

JAMES F. LINCOLN

DR. E. E. DREESE

R. A. Martin, employed as sales manager for the past eight years for Morse Brothers M.&S. Company, Denver, Colo., has recently accepted a position with the Babb Machinery Company, Picher, Okla.

Denver Metal & Machinery Company has purchased the Morse Brothers Machinery & Supply Company, Denver, Colo., and the latter company will be managed by Max Grimes and J. T. McShane and will be known as Morse Brothers Machinery Company.

Pacific Wood Tank Corporation, 461 Market St., San Francisco, Calif., has been formed by Fred W. Schmitz, Phil J. Maas, and G. A. Patey—all formerly with Pacific Tank & Pipe Company, of San Francisco. The new company will provide a complete service of engineering, designing, and installation of wood-stave tank and pipe products.

Allis-Chalmers Manufacturing Company, Milwaukee, Wis., announces that its subsidiary company, Condit Electrical Manufacturing Corporation, of Boston, Mass., will be operated as a company unit after Jan. 1, 1937. After that date the plant will be known as Allis-Chalmers Manufacturing Company-Condit Works. The address is 1344 Hyde Park Ave., Boston, Mass.

J. H. Mitchell-Roberts, export manager for Oliver United Filters, Inc., is on an extended trip throughout the Far East, visiting in the Philippines, Japan, Australia, and other countries.

BULLETINS

V-Belt Drives. Rockwood Manufacturing Co., Indianapolis, Ind. Data book No. 782, containing general information and tables on multiple-groove drives from ½ to 500 hp. motors. Pp. 31. Data book No.783 contains tables for selection of fractional hp. motors using single-groove drives. Pp. 11.

Classifiers. Colorado Iron Works, Denver, Colo. Bulletin 24H, containing illustrations, dimension tables, and performance graphs of the Akins spiral classifier. Pp. 30.

Wagon Mounted Drill. Ingersoll-Rand Co., Phillipsburg, N. J. Bulletin No. 2253 describes a new light-weight wagon mounting for rock drills. Pp. 4.

Crushing Rolls. Traylor Engineering & Manufacturing Co., Allentown, Pa. Bulletin No. 3627 describes the manufacturers' three different types of crushing rolls and tables of their setting dimensions. Pp. 41.

Dredge Cutter Heads. American Manganese Steel Co., Chicago Heights, Ill. Bulletin No. P8 contains illustrations of various types and sizes of cutting heads for hydraulic dredges. Pp. 8.

Conditioning Boiler Water. Elgin Softener Corp., Elgin, Ill. Bulletin No. 500 gives a non-technical discussion with tables and illustrations on conditioning various boiler waters. Pp. 16.

Brazing Alloys. Handy & Harman, 82 Fulton St., New York City, N. Y. New list of low-temperature silver brazing alloys and price list. Pp. 4.

Centrifugal Pumps. Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin W-313-B1 describes the improved Mixflo centrifugal pump. Pp. 8. Bulletin W-323-B1A describes the electrically operated automatic priming centrifugal pump. Pp. 2.

Sand Pumps. Allen-Sherman-Hoff Co., Lewis Tower, Philadelphia, Pa. Catalog 836 contains illustrations and tables and describes the complete line of "Hydroseal" sand pumps. Pp. 23.

Contractors' Bulletin. Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin WP-1061 shows compressed air, drilling, pumping, and miscellaneous equipment. Pp. 24.

Electric Drill. Wodack Electric Tool Corp., 4627 West Huron St., Chicago, Ill. Bulletin No. 361, a small folder describing portable electric drill and hammer.

Counter-Current Classifiers. Hardinge Co., Inc., York, Pa. Bulletin 30A describes the company's latest designed counter-current classifier and lists dimensions and types and operating information in installations.

Summary of the

MARKETS

SHARPLY higher prices featured the market in February. The upward trend, one of the most sensational under peace-time conditions, again followed London, where the boom became more intensified on predictions of a prolonged shortage in supplies, renewed investment purchases, and the announcement of a $7,000,000,000 rearmament program by Great Britain. Domestic producers advanced prices reluctantly, holding to the view that they have been marked up excessively. The boom in copper ran into open opposition when domestic producers decided late in the month to keep the quotation here below that of London.

Electrolytic copper in London (bid price) scored a net gain for the month of £17 5s. per long ton, settling at £74. On Washington's Birthday, Feb. 22, as well as on the following day, there were transactions in electrolytic copper abroad at the equivalent of 17.125c., c.i.f. basis. The domestic quotation opened the month at 13c., Connecticut, and ended at 15c. Domestic sales in February totaled 74,987 tons. Blister production during January for the world (Copper Institute) totaled 182,550 tons, against 171,118 tons in December. Apparent consumption of refined copper totaled 182,220 tons in January, against 161,709 tons in December. Total stocks of refined at the end of January amounted to 336,051 tons.

Lead advanced 1c. during February. Stocks again declined on reduced production, resulting from unfavorable weather conditions.

Prime Western zinc advanced 80 points to 6.80c., St. Louis. Stocks of zinc in the United States fell to 34,143 tons at the end of January, against 44,756 tons in December. Production of High Grade was restricted because of the weather.

The *E. & M. J.* index of prices for February was 91.68, against 87.03 in January.

UNITED STATES MARKET

1937 Feb.	Electrolytic Copper Domestic (a)	Electrolytic Copper Export (b)	Straits Tin New York	Lead New York	Lead St. Louis	Zinc St. Louis
1	12.775	12.325	49.900	6.00	5.85	6.000
2	12.775	12.475	50.500	6.00	5.85	6.000
3	12.775	12.600	51.000	6.00	5.85	6.000
4	12.775	12.750	50.550	6.00	5.85	6.225
5	12.775	12.800	50.000	6.00	5.85	6.250
6	12.775	12.850	50.125	6.00	5.85	6.250
8	12.775	12.875	50.375	6.00	5.85	6.250@6.400
9	12.775	13.000	50.225	6.00	5.85	6.400
10	12.775	13.075	50.525	6.00	5.85	6.400
11	12.775	13.150	51.250	6.00	5.85	6.400
12	12.775	13.275	Holiday	Holiday	Holiday	6.400
13	12.775	13.250	50.750	6.00	5.85	6.400
15	12.775	13.150	51.100	6.00	5.85	6.400
16	13.775	13.200	51.350	6.00	5.85	6.400
17	13.775	13.625	51.700	6.00	5.85	6.400
18	13.775	13.850	52.250	6.25	6.10	6.600
19	13.775	14.300	53.875	6.50	6.35	6.60@6.80
20	13.775@14.775	14.900	54.000	6.50	6.35	6.80
22	Holiday	15.950	Holiday	Holiday	Holiday	6.80
23	13.775@14.775	15.575	55.600	6.50	6.35	6.80
24	14.775	15.400	54.650	6.50	6.35	6.80
25	14.775	15.775	55.250	7.00	6.85	6.80
26	14.775	15.925	54.750	7.00	6.85	6.80
27	14.775	15.800	54.500	7.00	6.85	6.80
Av. for month	13.427	13.828	52.010	6.239	6.089	6.465
AVERAGES FOR THE WEEK						
Feb 3	12.775	12.396	50.208	6.00	5.85	6.000
10	12.775	12.892	50.300	6.00	5.85	6.308
17	13.108	13.275	51.230	6.00	5.85	6.400
24	14.175	14.996	54.075	6.45	6.30	6.750
CALENDAR WEEK AVERAGES						
Feb. 6	12.775	12.633	50.346	6.000	5.850	6.121
13	12.775	13.104	50.625	6.000	5.850	6.388
20	13.692	13.838	52.379	6.208	6.058	6.550
27	14.675	15.738	54.950	6.800	6.650	6.800

SILVER, GOLD, AND STERLING EXCHANGE

NEW YORK AND LONDON

1937 Feb.	Sterling Exchange "Checks"	Sterling Exchange "90-day demand"	Silver (c) New York	Silver London	Gold London	Gold (d) United States
1	4.89500	4.88750	44.750	20.1875	142s ½d	$35.00
2	4.89875	4.89000	44.750	20.1250	142s	35.00
3	4.89875	4.89000	44.750	20.0625	141s 11d	35.00
4	4.89500	4.88750	44.750	19.9375	142s	35.00
5	4.89125	4.88625	44.750	20.0625	142s 2½d	35.00
6	4.89250	4.88625	(e)	20.0625	142s 1½d	35.00
8	4.89250	4.88500	44.750	20.0000	142s 1 d	35.00
9	4.89250	4.88500	44.750	20.0000	142s 1 d	35.00
10	4.89500	4.88750	44.750	20.0000	142s ½d	35.00
11	4.89750	4.89125	44.750	20.1250	141s 11d	35.00
12	Holiday	Holiday	Holiday	20.0625	142s 2d	Holiday
13	4.89250	4.88625	(e)	20.1250	142s 2½d	35.00
15	4.89500	4.88875	44.750	20.1250	142s 1½d	35.00
16	4.89625	4.88875	44.750	20.0625	142s ½d	35.00
17	4.89375	4.88750	44.750	20.0625	142s ½d	35.00
18	4.89375	4.88750	44.750	20.1250	142s 1d	35.00
19	4.89125	4.88500	44.750	20.0625	142s 1d	35.00
20	4.89250	4.88625	(e)	20.0625	142s 1½d	35.00
22	Holiday	Holiday	Holiday	20.0625	142s 1½d	Holiday
23	4.89250	4.88625	44.750	20.1250	142s 1½d	35.00
24	4.89000	4.88375	44.750	20.0625	142s 2½d	35.00
25	4.88750	4.88000	44.750	20.1250	142s 2½d	35.00
26	4.88750	4.88000	44.750	20.1875	142s 3d	35.00
27	4.88625	4.87875	(e)	20.1875	142s 4d	35.00
Av. for month	4.89307	.....	44.750	20.083	.....	35.00
AVERAGES FOR THE WEEK						
Feb. 3	4.89729	.....	44.750	.....	.....	.....
10	4.89313	.....	44.750	.....	.....	.....
17	4.89500	.....	44.750	.....	.....	.....
24	4.89200	.....	44.750	.....	.....	.....

Calendar week averages: New York Silver, Feb. 6th, 44.750; 13th, 44.750; 20th, 44.750; 27th, 44.750.

(e) No quotation (Saturday).

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis, add 0.225c. per pound, the average differential for freight and interest charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Most sales in the foreign market are made on the basis of c.i.f. usual ports of destination—Hamburg, Havre, and Liverpool. The c.i.f. basis commands a premium of 0.300c. per pound above our refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c. per pound over the current market for Prime Western but not less than 1c. over the *E. & M. J.* average for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly mined domestic. Under Executive order issued April 24, 1935, the U. S. Government's price on newly mined domestic silver was established at 77.57. Handy & Harman's quotation for domestic silver, .999 fine, was 77c. per ounce throughout February.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in domestic and imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125 per ounce.

PRICES OF METALS • MISCELLANEOUS QUOTATIONS

LONDON MARKET

1937 Feb.	Copper Standard Spot	Copper Standard 3M	Copper Electrolytic Bid	Tin Standard Spot	Tin Standard 3M	Lead Spot	Lead 3M	Zinc Spot	Zinc 3M
1	52.7500	52.9375	57.7500	225.5000	226.2500	26.3125	26.2500	21.1250	21.5000
2	53.1875	53.3750	58.0000	227.0000	227.7500	26.4375	26.3750	21.1250	21.5000
3	54.2500	54.3125	58.7500	228.7500	229.5000	27.3750	27.3125	21.8125	22.1875
4	54.3125	54.5000	59.5000	229.5000	230.3750	27.3125	27.2500	22.1875	22.5625
5	54.8125	54.8750	60.0000	226.2500	227.2500	27.0000	27.0000	22.3750	22.7500
8	55.0625	55.2500	59.7500	227.2500	228.2500	27.4375	27.3750	22.5625	22.9375
9	55.5000	55.6875	60.2500	227.0000	228.1250	26.8125	27.0625	23.0625	23.3750
10	55.8125	55.9375	60.5000	226.2500	227.2500	27.0000	27.1250	23.2500	23.5000
11	56.3750	56.5625	61.2500	230.7500	231.7500	27.3750	27.3750	23.8750	24.1250
12	56.1875	56.3750	61.0000	228.5000	229.5000	26.9375	27.0625	23.7500	24.0625
15	55.8750	55.9375	61.0000	229.5000	230.5000	27.0000	27.0000	23.6875	23.9375
16	57.9375	57.9375	62.5000	230.2500	231.2500	27.3750	27.3750	24.4375	24.6250
17	58.8750	58.9375	63.5000	231.5000	232.5000	28.3125	28.3125	25.6250	25.6875
18	59.8750	59.8750	65.0000	234.0000	234.7500	28.6250	28.6250	27.0625	27.0625
19	63.6250	63.6250	68.0000	240.5000	241.0000	30.0000	30.0000	27.8750	27.8750
22	69.7500	69.7500	75.0000	248.0000	249.0000	30.8750	30.8750	30.2500	30.2500
23	65.0000	65.0000	69.0000	249.0000	250.0000	30.2500	30.2500	28.8750	28.7500
24	66.8750	66.8750	71.5000	240.5000	241.0000	30.5000	30.5000	29.6875	29.6875
25	69.0000	68.9375	74.0000	248.2500	249.0000	31.6250	31.6250	30.0000	30.1250
26	69.4375	69.1875	74.0000	246.7500	247.5000	31.8125	31.8125	29.8125	29.9375
Av. for month	59.225	.....	64.013	233.750	.....	28.319	28.328	25.122	25.322

CURRENT PRICES—MISCELLANEOUS METALS, ORES, AND NON-METALLIC MINERALS

Quotations cover wholesale lots, prompt shipment, f.o b. New York, unless otherwise stated

(March 1, 1937)

MISCELLANEOUS METALS

Aluminum, ingot, 99 plus per cent, lb.	20@21c
Antimony, domestic, spot, lb.	16.500c.
Bismuth, ton lots, lb.	$1.00
Cadmium, lb.	75c@$1.05
Chromium, 97 per cent grade, lb.	85c.
Nickel, electrolytic cathodes, lb.	35c.
Magnesium, 99.8 per cent, carloads, lb.	30c.
Palladium, troy oz.	$24.00
Platinum, (official quotation) troy oz.	$58.00
Quicksilver, flask of 76 lb., 100 flasks or more	$90.00@$92.00
Radium, mg. radium content.	$40.00
Selenium, 99.5 per cent, lb.	$2.00
Silicon, minimum 97 per cent, spot, lb.	16.50c.
Tellurium, lb.	$1.75@$2.00
Thallium, 100 lb. or more, lb.	$6.50
Titanium, 96 to 98 per cent, lb.	$6.00
Zirconium, commercially pure, lb.	$7.00

METALLIC ORES

Beryllium Ore, f.o.b. mines, ton.	$30.00@$35.00
Chrome Ore, 45@47 per cent, c.i.f. Atl. ports, long ton.	$19.00@$21.00
Iron Ore, Lake Superior, lower Lake ports, long ton:	
Old Range bessemer	$4.80
Mesabi bessemer	$4.65
Old Range non-bessemer	$4.65
Mesabi, non-bessemer	$4.50
Lead (Galena) 80 per cent Joplin, Mo., ton	$84.00@$85.02
Manganese Ore, c.i.f. Atlantic ports, long ton unit:	
52@55 per cent	34c.
49@51 per cent	32c.
44@47 per cent	27c.
Molybdenum Ore, 90 per cent, per lb. of contained MoS_2	42c.
Tungsten Ore, per unit of WO_3:	
Chinese duty paid	$18.50
Domestic Scheelite	$18.50
Vanadium Ore, per lb. of contained V_2O_5	27½c.
Zinc Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton.	$44.50

METALLIC COMPOUNDS

Arsenious Oxide (arsenic) lb.	3c.
Cobalt Oxide, 70@71 per cent, lb.	$1.41@$1.51
Copper Sulphate, 100 lb.	$5.35
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb.	$1.34
Sodium Sulphate, bulk, ton.	$13.00@$15.00

ALLOYS

Beryllium-Copper, Master alloy, 2.5 to 3 per cent Be, per lb. of contained Be.	$23.00
Ferrochrome, 65@70 per cent chromium, 4@6 per cent carbon, lb.	10c.
Ferromanganese, 78@82 per cent, gross ton.	$80.00
Ferromolybdenum, 50@60 per cent Mo, lb. of Mo contained.	95c.
Ferrosilicon, 50 per cent, gross ton.	$69.50
Ferrotungsten, 75@80 per cent, lb. of W contained.	$1.30@$1.40

NON-METALLIC MINERALS

Asbestos, f.o.b. mines ton:	
Canadian (Quebec)	
Crude No. 1	$550@.....
Crude No. 2	$200@$225
Spinning fibers	$90@$170
Paper stock	$32.50@$37.50
Shorts	$11@$14.50
Vermont	
Shingle stock	$47.50.....
Paper stock	$35@.....
Cement stock	$23@.....
Barytes, long ton:	
Georgia, crude	$7.00
Missouri, 95 per cent $BaSO_4$, less than 1 per cent iron	$5.50
Bauxite, long ton:	
Domestic, chemical, 55@58 per cent	$6@ $7.50
Domestic, abrasive, 78@84 per cent	$12.50@$15.00
Dalmatian, 50@55 per cent	(a)$5.50@ $7.00
French, 56@59 per cent	(a)$6.50@ 7.50
China Clay, f.o.b. mines, ton:	
South Carolina and Georgia, bulk	$6.50@ $9.00
Delaware, No. 1	$14.00@.....
Feldspar, bulk, ton:	
Potash feldspar, 200 mesh	$17.00
Glass-spar, white, 20 mesh	$11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85-5 per cent, all rail movement, ton	$18.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00@$14.00
Magnesite, per ton:	
Dead-burned, f.o.b. California	$25.00@.....
Dead-burned, f.o.b. Washington	$24.00@.....
Mica, per lb., North Carolina, No. 1 and 2 quality:	
1½ x 2 in.	15@30c.
2 x 2 in.	30@50c.
3 x 3 in.	75@$1.00
3 x 4 in.	$1.00@$1.25
4 x 6 in.	$2.00@$2.50
White, ground, 70 mesh, ton	$60.00@$80.00
Ocher, Georgia, ton	$19.00@$22.50
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports.	(a)12@12½c.
Silica, water-floated, in bags, 325 mesh, ton	$16.00@$40.00
Sulphur, Texas mines, long ton	$18.00@.....
Talc, f.o.b. works, ton:	
New York, double air-floated, 325 mesh	$12.00@$15.00
New Jersey, mineral pulp	$8.00@$10.00
Vermont, extra white, 200 mesh	$8.50@ $9.00
Tripoli, Missouri, ton:	
40 mesh, cream colored	$15.00@.....
200 mesh, cream colored	$25.00@.....

(a) Nominal.

IRON AND STEEL

Pig Iron, Valley furnaces, gross ton:	
Bessemer	$22.50
Basic	$21.50
No. 2 Foundry	$22.00
Steel, base prices, Pittsburgh:	
Billets, gross ton	$34.00
Structural shapes, 100 lb.	$2.05
Bars, 100 lb.	$2.20

Monthly and Yearly

AVERAGE PRICES

SILVER AND STERLING EXCHANGE

	New York		London Spot		Sterling Exchange	
	1936	1937	1936	1937	1936	1937
January	47.250	44.913	20.250	20.734	496.115	490.670
February	44.750	44.750	19.796	20.083	499.908	489.307
March	44.750	.....	19.663	.....	496.952	.....
April	44.892	.....	20.245	.....	494.139	.....
May	44.869	.....	20.248	.....	496.850	.....
June	44.750	.....	19.770	.....	501.817	.....
July	44.750	.....	19.590	.....	502.178	.....
August	44.750	.....	19.490	.....	502.519	.....
September	44.750	.....	19.579	.....	503.455	.....
October	44.750	.....	19.977	.....	489.755	.....
November	45.431	.....	21.050	.....	488.727	.....
December	45.352	.....	21.238	.....	490.670	.....
Year	45.087	.....	20.075	.....	496.924	.....

New York quotations for silver not eligible for sale to U. S. Government, cents per ounce troy, 999 fine. London, pence per ounce sterling silver 925 fine. Sterling exchange in cents.

COPPER

	F.O.B. Refinery, Electrolytic				London Spot (a)			
	Domestic		Export		Standard		Electrolytic	
	1936	1937	1936	1937	1936	1937	1936	1937
January	9.025	12.415	8.358	12.112	34.706	51.497	38.788	56.497
February	9.025	13.427	8.566	13.828	35.313	59.225	39.463	64.013
March	9.025	.....	8.708	.....	36.040	.....	40.227	.....
April	9.169	.....	8.849	.....	36.975	.....	41.131	.....
May	9.275	.....	8.819	.....	36.690	.....	40.839	.....
June	9.275	.....	8.790	.....	36.324	.....	40.357	.....
July	9.352	.....	8.993	.....	37.217	.....	41.228	.....
August	9.525	.....	9.297	.....	38.259	.....	42.375	.....
September	9.525	.....	9.523	.....	38.915	.....	43.267	.....
October	9.563	.....	9.669	.....	40.980	.....	45.295	.....
November	10.161	.....	10.349	.....	43.932	.....	48.467	.....
December	10.763	.....	10.835	.....	45.946	.....	50.364	.....
Year	9.474	.....	9.230	.....	38.441	.....	42.650	.....

New York quotations, cents per pound. London, pounds sterling per long ton. (a) Bid quotation.

LEAD

	New York		St. Louis		London			
	1936	1937	1936	1937	1936 Spot	1936 3 Mos.	1937 Spot	1937 3 Mos.
January	4.500	6.000	4.350	5.850	15.397	15.494	27.272	27.150
February	4.515	6.239	4.365	6.089	16.022	16.141	28.319	28.328
March	4.600	.....	4.450	.....	16.608	16.767	.....	.....
April	4.600	.....	4.450	.....	16.097	16.234	.....	.....
May	4.600	.....	4.450	.....	15.530	15.601	.....	.....
June	4.600	.....	4.450	.....	15.170	15.259	.....	.....
July	4.600	.....	4.450	.....	15.856	15.954	.....	.....
August	4.600	.....	4.450	.....	16.772	16.859	.....	.....
September	4.600	.....	4.450	.....	18.009	17.974	.....	.....
October	4.631	.....	4.488	.....	18.446	18.375	.....	.....
November	5.114	.....	4.964	.....	21.723	21.693	.....	.....
December	5.554	.....	5.406	.....	25.560	25.503	.....	.....
Year	4.710	.....	4.560	.....	17.599	17.655	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton.

TIN

	Straits New York		Standard, Spot London	
	1936	1937	1936	1937
January	47.234	50.925	209.731	229.350
February	47.962	52.010	207.081	233.750
March	48.037	.....	213.080	.....
April	46.963	.....	209.313	.....
May	46.352	.....	202.429	.....
June	42.204	.....	183.167	.....
July	43.021	.....	185.957	.....
August	42 579	.....	183.731	.....
September	44.754	.....	194.676	.....
October	44.975	.....	201.193	.....
November	51.392	.....	230.869	.....
December	51.823	.....	232.108	.....
Year	46.441	.....	204.445	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

ZINC

	St. Louis		London			
	1936	1937	1936 Spot	1936 3 Mos.	1937 Spot	1937 3 Mos.
January	4.848	5.847	14.488	14.719	21.153	21.281
February	4.859	6.465	15.125	15.391	25.122	25.322
March	4.900	.....	15.983	16.190	.....	.....
April	4.900	.....	15.181	15.334	.....	.....
May	4.900	.....	14.536	14.777	.....	.....
June	4.880	.....	13.896	14.122	.....	.....
July	4.783	.....	13.579	13.826	.....	.....
August	4.800	.....	13.528	13.759	.....	.....
September	4.850	.....	13.906	14.159	.....	.....
October	4.850	.....	14.554	14.835	.....	.....
November	4.974	.....	16.301	16.554	.....	.....
December	5.273	.....	17.957	18.145	.....	.....
Year	4.901	.....	14.920	15.151	.....	.....

St. Louis quotations, cents per pound. London, pounds sterling per long ton

CADMIUM AND ALUMINUM

	Cadmium		Aluminum	
	1936	1937	1936	1937
January	105.000	90.000	20.000	19.500
February	105.000	90.000	20.000	19.500
March	105.000	.....	20.000	.....
April	105.000	.....	20.000	.....
May	105.000	.....	20.000	.....
June	105.000	.....	20.000	.....
July	93.462	.....	20.000	.....
August	90.000	.....	20.000	.....
September	90.000	.....	20.000	.....
October	90.000	.....	20.000	.....
November	90.000	.....	20.000	.....
December	90.000	.....	20.000	.....
Year	97.789	.....	20.000	.....

Aluminum in cents per pound, 99 per cent grade. Cadmium, cents per pound.

ANTIMONY, QUICKSILVER, AND PLATINUM

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1936	1937	1936	1937	1936	1937
January	12.736	14.130	76.769	90.250	36.885	50.400
February	12.967	14.563	77.000	91.000	35.000	64.364
March	13.072	.....	77.000	.....	34.115	.....
April	12.673	.....	76.731	.....	32.846	.....
May	12.410	.....	74.940	.....	32.000	.....
June	11.707	.....	74.192	.....	36.346	.....
July	11.245	.....	73.423	.....	39.308	.....
August	11.125	.....	73.923	.....	49.577	.....
September	11.740	.....	85.280	.....	66.960	.....
October	12.058	.....	89.240	.....	54.074	.....
November	12.233	.....	90.250	.....	48.000	.....
December	12.918	.....	90.250	.....	48.000	.....
Year	12.240	.....	79.917	.....	42.926	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quick silver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

PIG IRON

	Bessemer		Basic		No. 2 Foundry	
	1936	1937	1936	1937	1936	1937
January	20.00	21.50	19.00	20.50	19.50	21.00
February	20.00	21.50	19.00	20.50	19.50	21.00
March	20.00	.....	19.00	.....	19.50	.....
April	20.00	.....	19.00	.....	19.50	.....
May	20.00	.....	19.00	.....	19.50	.....
June	20.00	.....	19.00	.....	19.50	.....
July	20.00	.....	19.00	.....	19.50	.....
August	20.00	.....	19.00	.....	19.50	.....
September	20.00	.....	19.00	.....	19.50	.....
October	20.00	.....	19.00	.....	19.50	.....
November	20.23	.....	19.23	.....	19.73	.....
December	21.00	.....	20.00	.....	20.50	.....
Year	20.103	.....	19.103	.....	19.603	.....

Iron in dollars per long ton. F. o. b. Mahoning and Shenango Valley furnaces